Chapter 1. What is Sustainable Agriculture?

Types of Agricultural Transformation

1.1 The process of agricultural modernisation during the 20th century has produced distinctly different types of agriculture, ranging from the `traditional' or `unimproved' to the highly industrialised (Chambers et al, 1989; Pretty, 1995; Conway, 1997). Systems endowed with access to roads and urban markets, modern crop varieties and livestock breeds, inputs, machinery, marketing infrastructure, transport, agro-processing facilities, credit, and water supply have been highly productive.

1.2 In developing countries, such systems tend to be monocrop and/or monoanimal enterprises, and so include lowland irrigated rice, wheat and cotton; plantations of bananas, pineapples, oil palm, sugar cane; market gardening near to urban centres; and intensive and extensive livestock rearing and ranching.

1.3 All the remaining `pre-modern' or `unimproved' agricultural systems tend to be complex and diverse, with low cereal yields - typically only 500-1500 kg/hectare. They are remote from markets and infrastructure; located on fragile or problem soils; and are less likely to be visited by researchers and extension workers. The poorest countries, in particular the low-income food deficit countries, have higher proportions of these systems. The livelihoods of some 30-35% of the world's population were still directly dependent on this agriculture in the mid-1990s (Pretty, 1995).

An Assets-Based Model for Sustainability

1.4 Agricultural systems at all levels rely for their success on the value of services flowing from the total stock of assets that they control. Five types of capital, natural, social, human, physical and financial, are now being addressed in the literature (cf Bourdieu, 1986; Coleman, 1988, 1990; Putnam, 1993, 1995; Costanza et al, 1997, 1999; Carney, 1998; Flora, 1998; Grootaert, 1998; Ostrom, 1998; Pretty, 1998; Scoones, 1998; Uphoff, 1998; Pretty and Ward, 2001):

Natural capital produces nature's goods and services, and comprises food (both farmed and harvested or caught from the wild), wood and fibre; water supply and regulation; treatment, assimilation and decomposition of wastes; nutrient cycling and fixation; soil formation; biological control of pests; climate regulation; wildlife habitats; storm protection and flood control; carbon sequestration; pollination; and recreation and leisure.

Social capital yields a flow of mutually beneficial collective action, contributing to the cohesiveness of people in their societies. The social assets comprising social capital include norms, values and attitudes that predispose people to cooperate; relations of trust, reciprocity and obligations; and common rules and sanctions mutually-agreed or handed-down. These are connected and structured in networks and groups.

Human capital is the total capability residing in individuals, based on their stock of knowledge skills, health and nutrition. It is enhanced by their access to services that provide these, such as schools, medical services, and adult training. People's productivity is increased by their capacity to interact with productive technologies and with other people. Leadership and organisational skills are particularly important in making other resources more valuable.

Physical capital is the store of human-made material resources, and comprises buildings (housing, factories), market infrastructure, irrigation works, roads and bridges, tools and tractors, communications, and energy and transportation systems, that make labour more productive.

Financial capital is accumulated claims on goods and services, built up through financial systems that gather savings and issue credit, such as pensions, remittances, welfare payments, grants and subsidies.

1.5 These five assets are transformed by policies, processes and institutions to give desirable outcomes, such as food, jobs, welfare, economic growth, clean environment, reduced crime, and better health and schools. Desirable outcomes, when achieved, feed back to help build up the assets base, while undesirable effects, such as pollution or deforestation, or increased crime or social breakdown, reduce the asset base.

1.6 The basic premise is that sustainable systems, whether farms, firms, communities, or economies, accumulate stocks of these five assets, thereby increasing the per capita endowments of all forms of capital over time. But unsustainable systems deplete or run down these various forms, spending assets as if they were income, and so leaving less for future generations.

1.7 The assets-based model described in Figure 1 shows how farms and rural livelihoods take inputs of various types, including renewable assets, and transform these to produce food and other desirable outputs. These can be processed for home consumption, transformed through value-added processes for sale, or sold directly as raw product. The inputs are shown as:

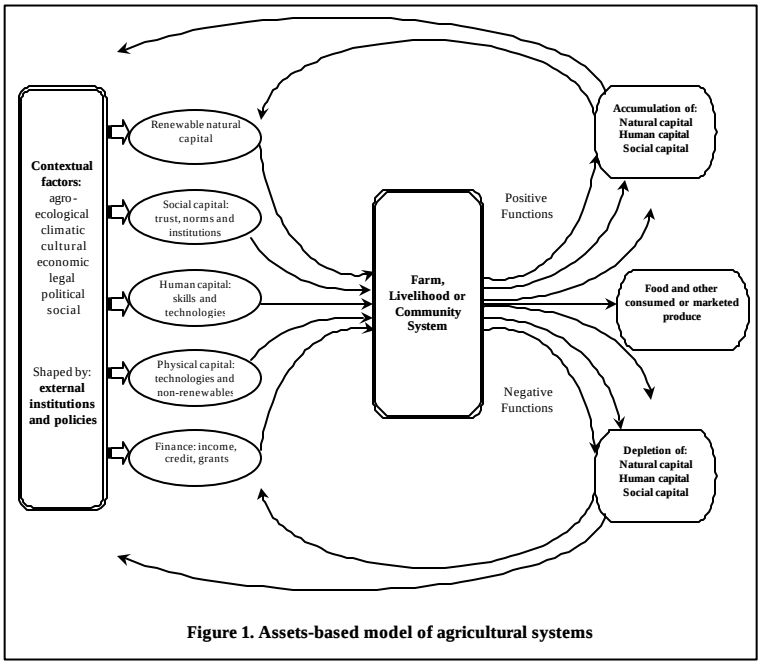

Figure 1. Assets-based model of agricultural systems

i. Renewable natural capital – soil, water, air, biodiversity etc;

ii. Social and participatory processes – including both locally embedded and

externally-induced social capital, and partnerships and linkages between external organisations;

iii. New technologies, knowledge and skills – both regenerative (eg legumes, natural enemies) and non-renewable (eg hybrid seeds, machinery);

iv. Non-renewable or fossil-fuel derived inputs (eg fertilizers, pesticides, antibiotics);

v. Finance – credit, remittances, income from sales and grants.

1.9. Availability and access to these five inputs is shaped by a wide range of contextual factors (on the far left). These include unchanging ones (at least over the short-term), such as climate, agro-ecology, soils, culture; and dynamic economic, social, political and legal factors shaped by external institutions and policies. These contextual factors are an important entry point for shaping and influencing agricultural systems (such as national policies, markets, trade).

The Multi-Functional or Multipurpose Nature of Agriculture

1.10 Unlike other economic sectors, agriculture is inherently multifunctional or multipurpose – it does more than just produce food, fibre, oil and timber. It has a profound impact on many other aspects of local, national and global economies and ecosystems. These impacts can be either positive or negative. A fundamental principle of sustainable systems is that they do not deplete capital assets, whilst unsustainable ones deplete them.

1.11 Two vital feedback loops occur from outcomes to inputs: agricultural systems shape and impact on the very assets on which they, together with many other sectors of economies, rely on for inputs. More sustainable agricultural systems, therefore, tend to have a positive effect on natural, social and human capital, whilst less sustainable ones feed back to deplete these assets.

1.12 For example, an agricultural system that depletes organic matter or erodes soil whilst producing food externalises costs that others must bear; but one that sequesters carbon in soils through organic matter accumulation both contributes to the global good by mediating climate change and the private good by enhancing soil health.

1.13 Equally, a diverse agricultural system that protects and enhances on-farm wildlife for pest and disease control contributes to wider stocks of biodiversity, whilst simplified modernised systems that eliminate wildlife do not. And agricultural systems that offer labour-absorption opportunities – through resource improvements or value-added activities – can help to reverse migration patterns.

1.14 Agriculture is, therefore, fundamentally multi-functional (Pretty, 1998; FAO, 1999). It delivers many unique non-food functions that cannot be produced by other economic sectors so efficiently. A key policy challenge (for both industrialised and developing countries) is clearly to find ways to maintain enhance food production. But a key question is: can this be done whilst seeking both to improve

the positive functions and to eliminate the negative ones.

1.15 It will not be easy, as past agricultural development has tended to ignore both the multi-functionality of agriculture and the pervasive external costs (Conway and Pretty, 1991; Altieri, 1995; Pingali and Roger, 1995; Conway, 1997; Pretty, 1998). Fortunately, there has emerged in recent years much evidence to illustrate that it is indeed possible to produce more food whilst enhancing natural, social and human capital.

The Modernisation of Agriculture

1.16 The process of agricultural modernisation during the 20th century has produced three distinct types of agriculture: industrialised, `Green Revolution', and all that remains - the pre-modern, `traditional' or `unimproved'. The first two types have been able to respond to modern technological packages, producing highly productive systems of agriculture. Their conditions were either like those where the technologies were generated, or else their environments could easily be homogenised to suit the technologies. These systems tend now to be endowed with access to roads and urban markets, modern crop varieties and livestock breeds, inputs, machinery, marketing infrastructure, transport, agroprocessing facilities, credit, and water supply.

1.17 In developing countries, modernised systems tend to be monocrop and/or monoanimal enterprises, and so include lowland irrigated rice, wheat and cotton; plantations of bananas, pineapples, oil palm, sugar cane; market gardening near to urban centres; and intensive and extensive livestock rearing and ranching.

1.18 The third type of agriculture comprises all the remaining `pre-modern', `traditional' or `unimproved' agricultural systems. Farming systems are complex and diverse, and cereal yields are low - typically only 500-1500 kg/hectare. They are remote from markets and infrastructure; located on fragile or problem soils; and are unlikely to be visited by agricultural scientists and extension workers or studied in research institutions.

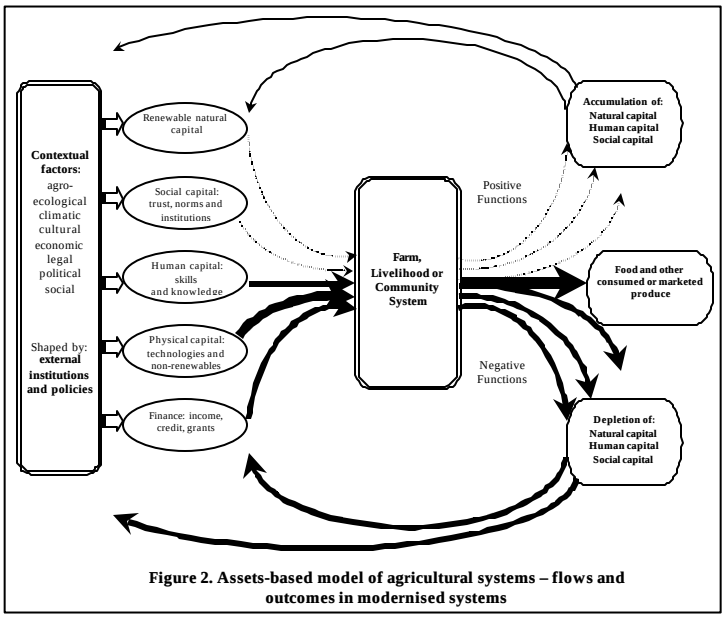

Figure 2. Assets-based model of agricultural systems – flows and outcomes in modernised systems

1.19 The poorest countries, in particular the low-income food deficit countries, have higher proportions of these agricultural systems. By the mid-1990s, some 30-35% of the world's population, about 1.9-2.1 billion people, were still directly supported by this third agriculture (Pretty, 1995).

1.20 Figure 2 illustrates the approach to agricultural modernisation on the assets-based model. These systems have become efficient transformers of new technologies, non-renewable inputs and finance to produce very large amounts of food, but with substantial negative impact on renewable capital assets (eg reduced natural capital, diminished labour).

Definition and Components of Sustainable Agriculture

1.21 What then do we understand by sustainable agriculture? And how then can we encourage transitions in both `pre-modern' and `modernised' systems towards greater sustainability - a sustainability that enhances both positive functions and eliminates the negative ones?

1.22 In the first instance, a more sustainable farming seeks to make the best use of nature's goods and services whilst not damaging the environment (Altieri, 1995, 1999; Thrupp, 1996; Conway, 1997; Pretty, 1995, 1998; Drinkwater, 1998; Tilman, 1998; Hinchliffe et al, 1999; Zhu et al, 2000; Wolfe, 2000). It does this by integrating natural processes such as nutrient cycling, nitrogen fixation, soil regeneration and natural enemies of pests into food production processes. It also minimises the use of non-renewable inputs (pesticides and fertilizers) that damage the environment or harm the health of farmers and consumers. It makes better use of the knowledge and skills of farmers, so improving their self-reliance. And it seeks to make productive use of social capital - people's capacities to work together to solve common management problems, such as pest, watershed, irrigation, forest and credit management (Figure 3).

1.23 Sustainable agriculture is also multi-functional within landscapes and economies – it jointly produces food and other goods for farm families and markets, but it also contributes to a range of public goods, such as clean water, wildlife, carbon sequestration in soils, flood protection, landscape quality. It delivers many unique non-food functions that cannot be produced by other sectors (eg on-farm biodiversity, groundwater

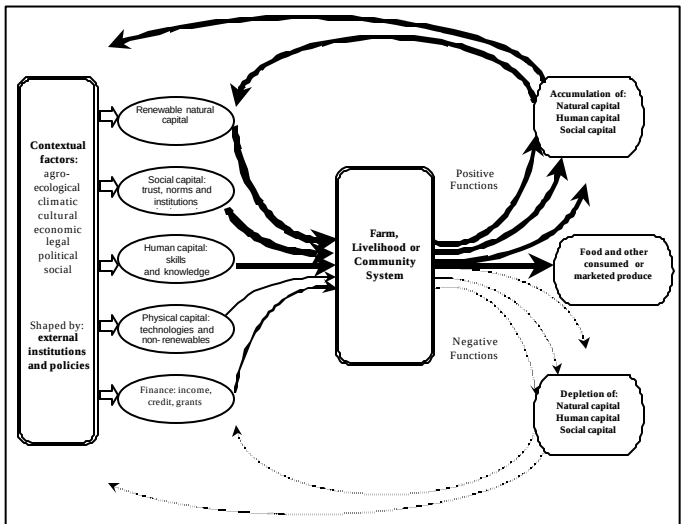

Figure 3. Assets-based model of agricultural systems – flows and outcomes in sustainable systems

recharge, urban to rural migration, social cohesion).

1.24 Sustainable agriculture is, therefore, defined as agricultural technologies and practices that maximise the productivity of the land whilst seeking to minimise damage both to valued natural assets (soils, water, air, and biodiversity) and to human health (farmers and other rural people, and consumers). It focuses upon regenerative and resource-conserving technologies, and aims to minimise harmful non-renewable and fossil-fuel derived inputs in the short-term and eliminate them in the long-term.

1.25 As sustainable agriculture seeks to make the best use of nature's goods and services, so the technologies and practices must be locally-adapted. They emerge from new configurations of social capital (relations of trust embodied in new social organisations, and new horizontal and vertical partnerships between institutions) and human capital (leadership, ingenuity, management skills and knowledge, capacity to experiment and innovate). Agricultural systems with high social and human capital are able to innovate in the face of uncertainty.

What Constitutes Success?

1.26 Assets-based thinking raises several questions about what constitutes success in agricultural systems. There have been two major failings about past agricultural development:

i) despite the great success of modernised systems in transforming new technologies, non-renewable inputs and finance to produce very large amounts of food[1], they have also had a substantial negative impact on renewable capital assets, such as reduced natural capital, negative effects on human health.

ii) despite the great success in increasing global gross food production, there remain an estimated 830 million people lacking adequate access to food, of whom 31% are in East and South-East Asia, 31% in South Asia, 25% in Sub-Saharan Africa, 8% in Latin America and the Caribbean, and 5% in North Africa and Near East (Pinstrup-Anderson and Cohen, 1999). Some 24,000 people die daily from hunger or hunger-related causes; and 10% of children in developing countries are still dying before the age of five (UN Hunger Project, 1999).

1.27 Environmental and health problems associated with agriculture have long been documented (cf Balfour, 1943; Carson, 1963; Conway and Pretty, 1991; EEA, 1998), but it is only recently that the scale has come to be appreciated. Recent studies have sought to put monetary values on the external benefits and costs of agriculture, so enabling comparisons between more or less sustainable systems. The external costs of agriculture in Germany, UK and the USA are some $30-350 per

[1] Wheat yields in India and Pakistan grew from 1.2 to 2.5 and 1.8 t/ha respectively from 1970 to 1995, and in Mexico from 3 to 4.2 t/ha; rice yields in China grew from 3 to 5 t/ha, in India from 1.6 to 2.8 t/ha, and in the Philippines from 2.2 to 4 t/ha; and maize yields in Latin America as a whole grew from 1.5 to 2.5 t/ha (Conway, 1997).

hectare of arable and permanent pasture (Pimentel et al, 1992, 1995; Steiner et al, 1995; Waibel and Fleischer, 1998; Pretty et al, 2000).

1.28 Modern rice cultivation can be costly to human health. IRRI researchers investigated the health status of Filipino rice farmers exposed to pesticides, and found statistically significant increased incidence of eye, skin, lung and neurological disorders (Rola and Pingali, 1993; Pingali and Roger, 1995). The health costs of these pesticide problems were calculated, and then incorporated into the economics of pest control strategies. This shows that modern, high-pesticide use systems suffer twice - lower net returns and higher health costs.

1.29 The so-called `complete protection' strategy, with nine pesticide sprays per season, returned less per hectare than the other two control strategies, and cost the most in terms of ill-health. Any expected positive production benefits of applying pesticides were then overwhelmed by the health costs. This indicates that rice production using natural control methods has multifunctionality in contributing positively both to human health as well as to rural livelihoods.