AGRICULTURAL INTENSIFICATION AND RURAL SUSTAINABLE LIVELIHOODS: A 'THINK PIECE'*

Grace Carswell

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Summary

This paper examines agricultural intensification as a strategy for achieving sustainable livelihoods, comparing evidence from a number of areas that have undergone such a process - in particular, the introduction of Green Revolution methods. Noting the variable impact the Green Revolution has had on different regions, crops and individuals, it reviews the explanations for these differences provided in the literature. The paper outlines the key conceptual questions surrounding intensification, setting them within the context of the broader environment and population debate. Citing evidence from Africa and Asia that challenges the simplistic assumption that population growth and environmental degradation necessarily go hand in hand, it demonstrates the complexity of the processes at work and discusses the importance of institutional factors, such as land tenure, in determining whether intensification is sustainable in the longer term.

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SECTION 1: INTRODUCTION

Rural people partake in a number of strategies, including agricultural intensification, migration and livelihood diversification, which enable them to attain a sustainable livelihood. This paper will examine agricultural intensification as a strategy for sustainable livelihoods. It will first define agricultural intensification, and some of the processes associated with it. It will examine a number of aspects of intensification using experiences of areas that have undergone agricultural intensification, with a focus on the consequences (either positive or negative) of intensification on livelihoods and their sustainability. Section 3 will outline different conceptual approaches to the question of agricultural intensification, set within the context of the population-environment debate, using a number of case studies to illustrate different experiences of intensification. Institutions, and how they mediate access to natural resources, and livelihood strategies, are central to the Sustainable Livelihoods Programme, and so Section 4 will examine land tenure as an example of an institutional arrangement that may be associated with agricultural intensification.

DEFINITIONS

Sustainable Livelihoods. A livelihood comprises the capabilities, assets and activities required as a means to a living. A livelihood is sustainable if it can cope with, and recover from, stresses and shocks, maintain or enhance its capabilities and assets and provide net benefits to other livelihoods locally and more widely, both now and in the future, without undermining the natural resource base. Furthermore, in the achievement of a sustainable livelihood the trade-offs between productivity, equity and sustainability are critical.[1] Indicators of sustainable livelihoods include consumption levels, access to assets, levels of human capital and processes such as resilience and adaptation. Using indicators such as these enables us to encompass both the quantity (or number) of livelihoods, and the quality of those livelihoods (in terms of health and well-being).

Agricultural intensification[2] has been defined as 'increased average inputs of labour or capital on a smallholding, either cultivated land alone, or on cultivated and grazing land, for the purpose of increasing the value of output per hectare' (Tiffen *et al.* 1994:29)[3] Agricultural intensification may occur as a result of a) an increase in the gross output in fixed proportions due to inputs expanding proportionately, without technological changes, b) a shift towards more valuable outputs or c) technical progress that raises land productivity. In practice the intensification process may occur as a combination of these, but the relative feasibility of the three components is likely to vary greatly in different areas.

For intensification to occur an increased demand for output is usually necessary. Alternatively a fall in the availability of a key factor such as land, water or labour may also necessitate intensification even if demand does not rise. (However, Pingali and Binswanger (1988) argue that there is a remarkable degree of substitutability of capital and labour, see Section 3.) Increased demand may be through population growth, in-migration or increased market demand in a country or region, or demand for higher value added output (such as fruit, vegetables etc.) when income per head grows. Agricultural intensification requires labour or

capital to enable the increased inputs necessary to raise the value of output per hectare. As some intensification techniques are ultimately labour saving, the presence of both additional capital and labour may not be necessary. (See mechanisation below.) Finally, and of particular interest to this project, the institutions in place must be such that the process of agricultural intensification can take place effectively. For example, the land tenure system must be such that people feel secure in their decisions to invest in land - this issue is discussed in Section 4.

The processes associated with agricultural intensification include an increased (per fixed unit of land) frequency of cultivation; an increase in labour inputs; or a change in technologies. Evidence of the increased use of natural or artificial fertiliser, improved seeds, animal traction, mechanisation, multi-cropping; or series/relay-cropping and changes to the landscape such as irrigation, or soil conservation measures would suggest that intensification was occurring.[4]

Agricultural intensification can be measured by the increased inputs per unit of land, by the frequency of cultivation (reduced fallow), or by total factor productivity (TFP). (Binswanger, *et al*. 1993). The narrower, and earlier definition (used for example by Boserup in her earlier writing) used land-labour ratios - i.e. the use of additional labour per hectare of cropping land. Frequency of cropping is usually measured as the percentage of time that land is occupied with an economic product, the assumption being that increased frequency of cropping follows from intensification. However a shift from a high yielding crop of 100 days per year to two low-yielding crops of 250 days per year (125 each) can not be described as intensification, though it may shift output value towards labour. Additionally, an area may be intensified without fallows falling (for example, the case of Kabale, Uganda (Lindblade *et al.* 1996)).

By increasing the value of output per hectare agricultural intensification may increase either (or possibly both) the quantity and quality of livelihoods and may increase livelihood sustainability. Agricultural intensification itself is usually conceived of as a positive process; something that agricultural systems should be encouraged towards. However, there may be negative effects of intensification - both in terms of the quantity of livelihoods, and the quality of those livelihoods, while there may be negative effects on the sustainability (environmental, economic etc.) of those livelihoods. For most people improvements in labour productivity provide the main opportunity for improvements in the quality of their livelihoods. This may however be at the cost of the quantity of livelihoods if there that not been an increase in output.

SECTION 2: PROCESSES INVOLVED IN, AND EXPERIENCES OF, AGRICULTURAL INTENSIFICATION

This section will examine the consequences of the processes involved in agricultural intensification for sustainable livelihoods, looking at areas that have experienced agricultural intensification through, in particular, the Green Revolution. The Green Revolution made available a package of biochemical inputs (HYVs, fertiliser and irrigation) that promised to be scale neutral and thus raise the yields and incomes of all farmers. (Bernstein *et al.*. 1992).While there is little doubt that the Green Revolution enabled massive increases in yields and the achievement of self-sufficiency in grains for India, it had a very uneven impact

on regions, crops, and individuals (Lipton and Longhurst 1989), while the negative environmental impacts have also been a cause for concern. A number of observations of the implications for sustainable livelihoods of the Green Revolution can be made.

Firstly, while the initial inputs associated with the Green Revolution were 'scale neutral' there has been, in some areas, a move towards other inputs such as mechanisation that are not scale neutral (for example, mechanical ploughing, harvesting and irrigation.) The implications of this in terms of the quantity of livelihoods are important and there is evidence of significant problems with agricultural intensification as a route to jobs. The fact that, in India and Bangladesh, the employment elasticity of HYV based yield expansion has fallen, and with it the number of livelihoods, is critical. Related to this is the effects of trends in farm size on employment[5] and on environment related behaviour, as both have implications for sustainable livelihoods.

Secondly, there is evidence that yield deterioration (and in some cases reversal) has been experienced and with it the rate of growth of intensification has been slowing down. (Rosegrant and Livernash 1996).This could be a result of environmental problems associated with intensification such as the loss of micro nutrients, problems with the water table, or low level pest build up. (Magnus 1996). The reduced genetic diversity of HYV crops means that there is a greater risk that pests or diseases that a plant variety has no resistance to, which develop resistance to chemical treatments, will spread quickly through the crop because of the crop's genetic uniformity. Declines in yields, environmental problems and reduced genetic diversity may have a negative impact on the quantity, quality of livelihoods as well as their sustainability.

Thirdly, many areas have been left out of the Green Revolution - in particular the Green Revolution has had a limited impact in SSA, and on rainfed production systems. (Hazell and Ramasamy 1991). It has been argued that this is because population densities in SSA are lower than in Asia there is less incentive to intensify production methods. (Binswanger and Pingali 1986). Others have argued that in SSA this is partly because of the dearth of suitable HYVs for many African staples. (Lipton 1988 and 1989). Lipton notes that 'even for maize, and especially for millets and sorghum, the rate of progress in yield enhancement has been much slower than for wheat and rice - particularly in SSA, and in areas where water supply is insecure. In the root and tuber crops, progress has been slower still.' (Lipton 1994:138) In addition to inadequate research and lack of water control, some have argued that price policies biased against food crops and rural producers have also acted as a constraint on production. However, as Lipton has observed, the response to price improvements in SSA has often been disappointing, and unless improved technologies are available there is little a farmer can do if the prices of farm crops rise. (Lipton 1994:141).

Comparing the experiences of India and Pakistan, and Kenya and Zimbabwe, Mosley (1994) has argued that the difference in yield growth between these countries is not dramatic and to speak of a Revolution in one, and non-Revolution in the other is not appropriate. However, such a comparison may not however be ideal as India and Pakistan as a whole are behind leading Green Revolution countries in Asia, while Kenya and Zimbabwe are ahead of African norms. Mosley argues that 'where the investment required for the effective adoption of HYVs is large in relation to the farmers' income, access to credit and the

output/input price ratio will be key determinants of the adoption rate.' As these are influenced by government policies and institutions, he argues that innovation should 'be seen as policy-induced rather than merely induced by naturally occurring input scarcities.' The examples provided by Mosley (i.e. Zimbabwe and Kenya) should however be seen as the exception in SSA rather than the rule. The majority of agricultural production systems in SSA remain low input, and only minimally intensified. Examples in SSA of what appear to be endogenously intensified, sustainable agricultural systems (e.g. Machakos in Kenya and Kano and Jos in Nigeria) will be discussed below. Before doing so, some of the processes associated with agricultural intensification are examined in closer detail.

The Green Revolution was essentially a package of inputs (fertiliser, high yielding seed varieties etc.) which were designed to lead to agricultural intensification. While there is some evidence that the fears that the Green Revolution would widen income disparities in rural areas, and perhaps make the poor worse off, have not been realised in every area that has experienced the Green Revolution (Hazell and Ramasamy 1991), the experiences have undoubtedly been mixed. The Asian experience has led to calls for increases in the use of inorganic fertilisers in SSA and for greater consideration to be given to biotechnology and new seed varieties.(Cleaver, and Schreiber 1994; Larson and Frisvold 1996; Leisinger 1995). Increased reliance on chemicals may have negative consequences for the environment and raises the question of both economic and environmental sustainability, and the consequences of such inputs on the quality of livelihoods. Pretty *et al.* (1996: 16) call for greater emphasis to be placed on 'sustainable agriculture' noting that 'a massive increase in inorganic fertilisers and pesticides is not a necessary condition for feeding the world [although] in certain agroecological systems, moderate applications of fertilisers will be necessary to ensure the appropriate balance of plant nutrients and minerals in the soils.' A more sustainable agriculture pursues a number of goals - the incorporation of natural processes such as nutrient cycling; minimisation of the use of external and non-renewable inputs; the participation of farmers and rural people in all processes of problem analysis and a greater use of local knowledge.

In seeking to explain why the adoption of improved maize has remained patchy in SSA, Byerlee and Heisey (1996) have concluded that it has been constrained in some cases by the failure to incorporate smallholder preferences adequately, and in others by insufficient supporting infrastructure. They call for greater attention to appropriate technology for the maintenance of soil fertility, which will require a combination of both external and internal sources of nutrients, and note that crop management technology must also be evaluated in terms of effects on seasonal labour demand.

It has been argued that irrigation, or better water management, is an essential component to increasing agricultural production, as better water security usually precedes biochemical innovations. (Although there have been cases of HYV successes in rainfed areas). Lipton and Longhurst (1989: 70-1) have argued that strategies to improve water control, as well as improved crop varieties and use of fertiliser are vital as 'without external water security... farmers may not risk fertilisers; without fertilisers and MVs, neither food supply nor rural employment income can often keep up with 3 per cent annual population growth... [Thus] food security requires water security.'

While irrigation may be a theoretical solution to agricultural problems of arid or semi-arid lands, and there is evidence that there is a substantial area of potentially irrigable, but undeveloped land in SSA (FAO 1986, quoted in Adams 1992), the results of irrigation works in SSA suggest that this is not straightforward.[6] The unsuccessful attempts at large-scale irrigation in Africa over the past two decades illustrate the problems well.[7] Massive investments in irrigation in Nigeria, Kenya, Senegal, amongst others, failed to produce the expected results. High overhead and management costs, underestimation of construction costs, inaccurate irrigation cost/benefit analyses, technical problems, and management problems have all contributed to these failures. Furthermore, the suggestion that these problems have been confined to large scale irrigation is questionable, as Adams (1992: 180) shows 'there are large numbers of small-scale irrigation schemes in Africa that work no better that their more infamous larger neighbours ...[as they have] been rather costly, and bad at meeting the needs of the poor. Very often they have been little more than scaled-down versions of large projects.' Despite recognition of the problems associated with irrigation in SSA the significance of investment in irrigation continues to be emphasised (Cleaver and Donovan 1995) and this research project should consider the scope for water control (particularly farmer controlled micro irrigation), and the implications of better water control for livelihoods.

While mechanisation is sometimes associated with agricultural intensification, it does not necessarily lead to a rise in output per hectare and so in total factor productivity and so it may not actually give rise to agricultural intensification. Mechanical inputs may raise output per worker-hour, and in doing so free up labour (and other equipment) to farm new land, viz. to extensify (Ishikawa 1967; Bray 1986).[8] Binswanger's study of south Asia (1978) has shown that tractorisation in itself did very little to improve yields, cropping intensities or timeliness and thus very little to increase land productivity. Arifin's study (1993) of the impact of packages of intensification in Indonesia confirms that 'mechanisation has no direct effect on land productivity but the use of bio-chemical inputs does.' Mechanisation will, however, lead to intensification when, for example, tractorisation enables double cropping, (Farrington and Abeyratne 1982), or when mechanised threshing is used to save family farm labour, which is then released to work on the next (HYV) crop.

A number of studies have stressed that the traditionally emphasised determinants of production are not the only ones that are important. Reardon *et al.* (1994 and 1995) have stressed that in addition to these traditionally emphasised determinants of productivity (variable input use, fertiliser, manure, improved seed etc.) and capital investments (animal traction etc.) also important are non-farm income, soil conservation investments and market infrastructure improvements. These are important to productivity and to the use of key inputs. They also note that policy reform alone (e.g. exchange and interest rate policy, market liberalisation, privatisation) is important but is not sufficient to spur high production, and there is a need to tackle directly resource, technology and market constraints. Similarly Guyer and Lambin (1993) have noted that agricultural practice is developing in dynamic fashion in advance of population pressure, largely due to market responses.[9] A number of studies (Schelhas 1996; Roumasset *et al.*, 1979) have suggested that risk,

and the perception of risk, is a key factor influencing the nature and timing of intensification and diversification decisions.

A recent study of the evolution of commercial vegetable gardening from 1971-88 in the Philippines (Eder 1991) found that there had been a two to three fold increase in labour invested per unit of land in gardening itself. Returns to gardening labour were greater in 1988 than 1971 because of increased market opportunities, improved efficiency in production and marketing and technical change, as well as changing socio-economic characteristics of local communities and the role of state. Binswanger and Khandker (1993) have taken the latter point further in their examination of how financial institutions and interest rates determine investment, input and output decisions in India. They found that the availability of banks are a more important determinant of fertiliser demand and aggregate crop output than interest rates. Government decisions about investment in infrastructure are related to agroclimatic potential, while banks decisions about their location related to both infrastructure and agro-climate.

The importance of understanding the broader political and economic climate to explain the presence (or absence) of agricultural intensification has been highlighted by a number of studies. For example Conelly (1994) sought to explain why farmers on Rusinga Island in Kenya have abandoned intensive agricultural practices. He explained disintensification because of labour scarcity (because of wage labour and fishing), and called for a greater understanding of broader political and economic environment to explain decisions. Similarly in Usagara, Tanzania a change from cotton to rice, and the increased use of manure as fertiliser, can be explained in part by the changing factor prices, related to the removal of subsidies on fertilisers (ICRA 1990).

The significance of the broader policy environment is highlighted by the impact of SAPs and a number of studies have examined this.[10] Mosley (1994) notes that SAPs may raise output prices, but they also lead to increases in input prices and fail to solve the problem of an imperfect capital market. It is this lack of capital markets (access to credit) that Mosley sees as critical. Further studies of the effects of SAPs on agricultural production include the effect of devaluation in Senegal. Kelly *et al.* (1995) has observed that in Senegal the use of fertiliser has declined over the years of structural adjustment. Farmers compensated to protect yields by increasing peanut seeding density, which creates 'vicious circle of soil exhaustion and increased seed density.'[11] A more recent study by Diagana and Kelly (1996) examines how the profitability of main crops has changed and affected the choice of crop mix and technology; and argues that devaluation has not, in the short run, encouraged farmers to sustainable patterns of intensification characterised by high fertiliser use. Rather, they note that 'very low fertiliser use... plus the extensive use of high peanut seeding densities provide maximum profits in the short-run but cannot be sustained in the long-run'.

SECTION 3: CONCEPTUAL ISSUES IN THE STUDY OF AGRICULTURAL INTENSIFICATION

Having examined some of the specific processes related to agricultural intensification, this section will outline some of the broader conceptual debates surrounding intensification set in the context of the

population-environment debate (Turner *et al.* 1993; Lee *et al.* 1988; Berry 1984). Malthus (1798) argued that where population increases were not subject to checks, populations increase exponentially, while due to diminishing returns to labour and capital, production increases arithmetically and output per head declines. Initially Malthus argued that population would only decline through 'natural checks' such as famine and pestilence, although in his later writings (1830) he amended this to include falling birth rates as a result of 'moral restraint'. Malthus also argued that growing populations would expand into more marginal land, and returns to labour would inevitably decline. He noted that any improvements in production techniques, which occurred more by chance than anything else, would induce further population growth, raise labour supply and food demand but because of the diminishing conversion efficiency of labour (and land) into food, such improvements effectively cancel themselves out.[12] Following Malthus some have argued that population growth rates are such that it will impossible to maintain adequate food supplies, and environmental decline will inevitably result.[13]

Others have taken on the 'Neo-Malthusians', and argued that there are few resources which are not replaceable (Jolly 1994; Hogan 1992), while increased population density actually induces positive changes which offset the decrease in the land available (Boserup 1965 and 1981). Those associated with Boserup see population growth as having positive effects, in particular being the major stimulus for intensification, with technological change leading to greater productivity.[14] Boserup (1965) argued that increasing population pressure provides the primary stimulus for innovation and intensification. Key responses to population pressure include increased cropping intensities (with shorter and less frequent fallows) and the introduction of land saving techniques. She has defined agricultural intensification as 'the gradual change towards patterns of land use which make it possible to crop a given area of land more frequently than before.' (Boserup 1993: 43). Boserup's argument focuses on a number of stages in the frequency of cropping - each stage has different cultivation techniques and the model implies a progression from less to more intensive cultivation. Thus increased population pressure results in a shift from forest fallow, to bush, then grass fallow, annual and finally multi-cropping. At heart of the model is the notion of technological change induced or impelled by a 'critical' population density. She concedes that very high population growth rates are unlikely to fit this model.

A number of studies (for example Pingali *et al.* 1987; Ruthenberg 1980) have examined the relationship of agricultural intensification under increased population. Examining Boserup's thesis, Pingali and Binswanger show that there is a 'remarkable degree of substitutability of capital and labour for land, so that in the long run returns to agricultural labour appears to decline quite slowly as population density increases.' (1988: 5) They suggest that farmer generated technical change is capable of sustaining slow and steady population increases with modest increases in agricultural output, but may not be capable of supporting rapidly rising populations. At this stage, large scale technical changes need to take place. They note that while farmer based innovations and the intensification of agricultural systems are constrained by agro-climatic conditions, a pattern can be observed in the degree of investment in the land. In the early stages of intensification there is almost no investment - land is simply cleared, but tree stumps are left. As

intensification increases the tree stumps are removed and boundaries of plots are more clearly defined. The most easily worked soils, on which cultivation begins, are also the most susceptible to erosion, and so protective devices such as ridging and the construction of terraces are used - these were used in the pre-colonial period in some of the more densely populated parts of Sub-Saharan Africa (Allan 1965: 386). Harder to work soils are increasingly cultivated as population continues to increase, with labour intensive measures such as drainage being undertaken once population pressure makes this remunerative. Additionally as farming intensities increase more labour intensive fertiliser techniques such as composting and manuring are increasingly used (Pingali and Binswanger 1986).

Thus, in areas of high population density where increased agricultural output can no longer come about through the extension of land under cultivation, there must be a move towards the more intensive use of land. This entails increasing the frequency of cultivation (by reducing fallow periods) and increasing labour and technical inputs so that output per unit area of land increases. As Turner *et al.* (1993) observe such growth does not necessarily improve per capita production which normally needs technological change, including land improvements such as irrigation and the construction of terraces. These technical changes take place in a step pattern as thresholds of demand are met and the investment is made. Each step involves major improvements in land productivity and improvement in per capita production.

The distinction between agricultural intensification which results from increasing populations generating technologies that grow more food per hectare, (associated with Boserup) and intensification which results from increasing populations inducing rises in labour use per hectare as labour becomes more plentiful relative to other factors (Hayami, Ruttan, Binswanger) has been made by Lipton (1989). As population grows both forms of intensification are needed for poverty reduction to meet, respectively food availability constraint and food entitlements constraint as population and labour supply grows.

Binswanger and Ruttan (1978) have observed that agricultural intensification is not driven by population growth alone, and successful innovation may be induced by policy. In the induced innovation model technical and institutional changes required to develop agriculture are endogenously derived as a result of change in resource endowments and demand. Technical change could be induced by changes in the land-labour or fertiliser-land price ratios. These changes in relative resource endowments are viewed as directing technical change along a path that permits substitution of relatively abundant factor for relatively scarce factors of production. Thus technical progress would relax the constraint on the growth of productivity under given resource endowments. For example, constraints imposed by inelastic supply of land may be compensated by advances in biological technology, while mechanical technology may relax the constraints imposed by an inelastic supply of labour (Hayami and Ruttan 1985).[15] However, it is worth noting that rarely does agricultural research focus on creating labour, and thereby increasing the number of livelihoods. Rather agricultural research is aimed towards a more efficient agricultural system which may mean finding ways of reducing labour costs (Lipton 1988; Hayami and Ruttan 1985).

Lele and Stone (1989) observed that agricultural intensification may occur autonomously or spontaneously as land is cropped more frequently in response to higher population densities; (Boserupian

output intensification response) or may occur as a result of policy and incentives to shift to crops of higher value. The changes in the relative opportunity costs and factor endowments resulting from population growth will be especially visible in the first type of intensification. They argue that Boserup may have understated some of the negative aspects of intensification such as environmental degradation and note that there are problems associated with intensification in conditions of very rapid population growth whereby environmental damage may outweigh the effects of autonomous intensification. They also note the need to include measures of output and productivity as well as frequency of cropping.

Pingali, Bigot and Binswanger's study (1987) of mechanisation in SSA concluded that population growth and access to markets were the main determinants of intensification, and these findings have been supported by more recent studies. For example Turner, Kates and Hyden's (1993) comparative study of agricultural intensification in SSA supports the induced intensification model. In these cases levels of cropping frequency had been achieved 'everywhere primarily by major increases in labor (amount per hectare) and by modest increases in capital inputs (monetary investment).' (Turner *et al.* 1993: 402). In most areas farmers had experimented with new cultigens and biotechnic inputs (pesticides etc.), and these increased inputs had led to intensified outputs in every case, and in 8 out of 10 cases there had been increases in total agricultural production. In all cases there was significant market production and other forms of economic diversification were increasing. They concluded that 'substantial increases in the overall low population densities of SSA can be matched by increases in agriculture, even in areas that are relatively poorly endowed for cultivation'. This must however be dependent on the availability of suitable technologies and seeds. They found greater variability as to the way that increasing population generated diversification in labour, market orientated production, capital investment in agriculture and adoption of modern technology, although in all case studies economic diversification was on the rise. Turner *et al.* also observed some of the negative consequences of agricultural intensification, in particular involution, diminished well-being, and environmental degradation. Involution occurs when increasing demand is met by output intensification but at the costs of decreasing or small marginal and average returns to outputs. They note that intensification can lead to real losses in social, cultural and economic well-being.[16] With economic diversification and out migration on the rise, agriculture is increasingly maintained by intensified use of 'remaining' labour, and this, in the SSA context, will probably mean labour for the individual farmer (often a woman) (compared to South Asia where it may offer employment for rural landless). Intensive land use may mean increased competition and conflict over land - especially in areas of high density (Bassett and Crummey 1993). As credit, technical inputs, market opportunities etc. are not equitably distributed intensification may lead to systematic differentiation. Indeed their evidence suggests that social differentiation was increasing in seven of the ten cases (e.g. access to land) and gender roles were changing significantly. There is some evidence that women farmers are especially at a disadvantage with new technologies and inputs (Mackintosh 1989; IRRI 1983).

Turner *et al.*. (1993: 406) suggest that 'long term population growth and economic development usually do not take place without intensification and agricultural growth, although intensification and

agricultural growth do not inevitably follow population growth and are not necessarily beneficial or sustainable.' They note that agricultural intensification can threaten the longer term sustainability of the agricultural resource base. Furthermore the degree to which additional inputs (such as fertilisers and terraces) can compensate for decreases in fallows etc. has been questioned (Ho 1985; Lele and Stone 1989). However, in the face of increasing population with no additional land available, there may be few alternatives.

Turner *et al.* concluded that conditions associated with favouring agricultural successes included 'favoured environments' being 'those that offer least resistance to production, or can be altered or transformed to reduce resistance at minimal costs'; 'Promising Locations 'being those that provide economic benefits beyond their environmental conditions'; 'Regions of Refuge or Deep Attachment' being areas which may be more marginal but where the population feels secure and so invests in landscape modifications to sustain intensive agriculture; and areas with supportive socio-economic organisations and structures. The significance of supportive socio-economic organisations and structures in ensuring sustainable agricultural intensification will be returned to in Section 4. Furthermore the constraints to further intensification that they identified included technical limitation, inadequate market development, customary resource allocation rules, withdrawal of needed labour, and possible problems associated with environmental degradation in particular where other constraints and conditions have inhibited land improvements or where the physical or biological constraints have made the area vulnerable. Being under-researched or under-irrigated such areas may be left out of intensification and as a result may see the quality and quantity of livelihoods threatened. (Hazell and Ramasamy 1991).

In connection with environmental impacts, Turner *et al.'s* (1993: 409) findings suggest that 'degradation of a severity that destroys agriculture does not necessarily follow from high population pressures or intensive agriculture.' They concluded that severe environmental degradation was associated with agriculture in 1) extreme rural densities where economic diversification was not able to substitute adequately for the increasing population; 2) physically or biologically vulnerable areas; and 3) areas where the socio-economic organisation impedes the implementation of conservation strategies. They note that 'where farmers have extensive knowledge about the environment that they manage, perceive that their capital and managerial investment is in their own interest, and have a socio-economic organisation facilitating this management, environmental problems can be confronted successfully.'

The significance of both the market and infrastructure in the process of agricultural intensification have been further confirmed by a number of studies in both Africa and Asia.[17] Cases from India and Nigeria suggest that the introduction of suite of new technological components (new crops, fertiliser, new power sources etc.) altered land use patterns and changes in the labour economy. It is questionable whether population growth alone could have lead to such transformations which, it has been argued. have been driven by market production (Goldman and Smith 1995).

THE MACHAKOS CASE

The findings of Turner *et al.* are corroborated by those of a more recent study by Tiffen *et al.* (1994). This examined the Machakos area of Kenya, where concerns amongst colonial officials about the unsustainability of the agricultural system led them to attempt to implement various soil conservation policies from the 1930s. Strong opposition by the local population led, however, to the abandonment of these policies. What is so significant about this case study is that in the post-colonial era the productivity of the area appears to have increased as people have decided to invest (with both labour and capital) in their agriculture, doing many of the things that they have refused to do when instructed to in the colonial era. The study, an example of post-colonial intensification, concludes that an increase in population density over a 60 year period, combined with a favourable policy environment, induced environmentally positive changes in land utilisation. They suggest that population density was the key and rising densities from a low base facilitated more productive agriculture and greater specialisation and exchange within society. Malthusian outcomes were avoided by migration, diversification of incomes (and an increase in non-agricultural incomes) and agricultural intensification through new technology, improved livestock etc. The study highlights the importance of considering a longer time framework to examine the process of agricultural intensification. The Machakos evidence supports revisionist thesis that increased population density can induce the necessary social and technical changes to bring about better living standards, given a policy environment which encourages trade and the spread of knowledge, and provides security for investments. Tiffen *et al.*'s study illustrates how local communities can respond spontaneously to land degradation and make land improving investments that significantly increase productivity over time. Thus population increase is compatible with environmental recovery provided that market development makes farming profitable. New market opportunities were shown to have stimulated investment and innovation, although some of the necessary capital was from outside agriculture.

Other studies have also suggested that global correlations between population growth and environmental degradation cannot be extended to a local level. For example, a recent study in Kenya has found that at a district level woody biomass increased at a rate greater than population growth (Holmgren *et al.* 1994; Arnold and Dewees 1995). Other studies have challenged the view that agricultural intensification is a threat to soil fertility in SSA. A study of Jos Plateau, Nigeria, has shown that intensification has enhanced soil fertility despite shortages of organic fertiliser, cash and labour, through indigenous knowledge/ techniques (Phillips-Howard and Lyon 1994). The findings suggest that given appropriate incentives and marketing opportunities, resource poor farmers elsewhere in Africa will also apply their knowledge towards maximising the fertility of their soils. Similar findings have been made in Kano, Nigeria, (Harris 1995) where production has been intensively farmed successfully for 30 years under annual cultivation. Research suggests that in this area the key to the farming system is integration of crops with livestock, as well as the use of legumes and inorganic fertiliser. High labour availability has contributed to the processes necessary to support sustainable agricultural intensification (e.g. increasing use of crop residues to feed livestock and eventual shift to full crop-livestock integration.)

The tendency to analyse change to African agricultural systems as an essentially progressive process has been observed by Anderson (1989) who noted the problems with this postulation of linear progress. He uses the example of the rise and decline of irrigation in Baringo, Kenya, in C19 to illustrate the dangers of assuming that agricultural change is incremental to 'progress'. Rather, as in the case of Baringo, irrigation expanded at a specific time because of the conjuncture of a number of factors, and it died when this conjuncture fell apart.

Another historical study has similarly been critical of the unilineal model, arguing that diversity and variability are critical aspects of the structure of agricultural production and process of intensification. Using the case study of late pre colonial southern India, Morrison (1996) suggests that 'multiple strategies of agricultural production were pursued simultaneously and that the course of change was itself complex'. Similarly Ramish (1996) has observed that to link case studies as if they were on some sort of agro-technical continuum is to ignore the possibility that credit, technical inputs and market opportunities are not equitably distributed and may lead to systematic differentiation based on class, ethnicity, etc. The problems of associating agricultural intensification with increased frequency of cultivation has been highlighted in two studies of the Kabale district of Uganda (Grisley and Mwesigwa 1994; Lindblade *et al.* 1996). These showed that increasing population was **not** associated with falling fallow. In this situation farmers have intensified land use through intercropping, rather than reducing the percentage of land in fallow. Thus while the Boserupian model would suggest that population pressure stimulates innovation and agricultural intensification leads to reduced fallow and technical change, the results of this study suggested that population pressure led to intensification through measures that did not include reduced fallow. Farmers could not afford the costs involved in reducing fallow (costs seen through reduced yields) and so intensified through increased intercropping, use of trash etc. In addition there may have been an increased reliance on off-farm incomes and remittances.

These findings (Machakos, Jos, Kano etc.) suggest that some areas are adaptable to stresses of rising people/land ratios. A note of caution should be added that all of SSA may not be resilient as these cases, and such findings should not be extended too generally. That said, the case of Machakos will be examined further as the consequences of agricultural intensification on sustainable livelihoods has been further examined since the Tiffen *et al.* study.

TAKING THE MACHAKOS CASE A STEP FURTHER

Tiffen *et al.*'s study has been criticised for relying too much on aggregate level statistics[18], and the question of whether it accurately reflects the experiences of the people of Machakos has been raised (Rocheleau 1995). In particular the issue of whether 'these examples of sustainable *resource use* have been compatible with the maintenance of sustainable *livelihoods* in such marginal African environments' has been examined by Murton (1997: 1).[19] Using longitudinal data to investigate the process of change in the area, Murton has examined in detail how the process of agricultural intensification has been experienced by the people of Machakos. He found that 'people's experience of agricultural intensification... was a complex one which

had been neither unproblematic nor universally shared. Many people in the area were experiencing a deterioration of their livelihoods amidst the widespread conservation of the surrounding physical environment. This was mirrored by the polarisation of land holdings within the study area, largely as a result of differential access to non-farm income and urban remittances. Whilst many people have enjoyed rising living standards, there are others whose livelihood sustainability ... is greatly threatened.'

Murton's research highlights a number of factors essential for successful intensification, namely the presence of sufficient labour and working capital. He observes that in Machakos there were phases in the process of agricultural intensification - in the early stages it could be achieved through increased household labour (e.g. through terracing, increased frequency of cultivation etc.) but in later phases intensification was dependent on the ability to use new innovations, such as fertilisers and pesticides, which had to be bought with cash. Initially therefore labour intensive paths of intensification (pro quantity of livelihoods) were followed, while in the later stages farmers access to non-farm incomes was crucial. Murton's findings enable him to question some of Tiffen *et al.*'s findings. In particular whether 'the sustainable transformation of the Machakos agricultural **environment** has been translated into sustainable **livelihoods** for all those living in the area.' He notes that rather than all farmers 'proceeding along a Boserupian or Simonian pathway of increasing inputs and increasing yields per hectare and per person, [a significant numbers of farmers] ...have proceeded along involutionary pathways of declining yields, diminishing fertility and falling returns to labour, unable to supply the capital inputs necessary to enable more productive agricultural intensification' (1997: 5).

These findings therefore suggest an alternative to the linear Boserupian model. Furthermore they suggest that the responses to Boserup (population/food) and Hayami-Ruttan (labour/land) incentives were private and endogenous, although a favourable wider policy environment was also crucial. In contrast the agricultural research that generated the Green Revolution was a large, planned, multi-government response. Thus far this paper has outlined the process of agricultural intensification, the conceptual issues related to it and has examined a number of case studies of agricultural intensification. The evidence outlined above suggests that a number of different trajectories are possible:

- people can intensify their agriculture in a sustainable way
- the benefits of such intensification may not be evenly distributed or experienced
- involution may occur whereby increased inputs experience marginal returns
- intensification may not occur at all

Furthermore such multiple trajectories of change can exist side by side; and the effects of agricultural intensification can be either positive or negative on either or both the volume and quality of livelihoods and the sustainability of those livelihoods. For example intensification may have a positive effect on production, but negative effects on environmental sustainability and equality. In seeking a greater understanding of the range of experiences of intensification the following section will briefly examine the role that institutions play in the process of agricultural intensification.

SECTION 4: INSTITUTIONS AND AGRICULTURAL INTENSIFICATION

The Sustainable Livelihoods Programme seeks to understand how different institutions mediate (i.e. constrain or enable) the strategy of agricultural intensification, and how they mediate the attainment of a sustainable livelihood. For the purposes of this paper 'institutions' comprise both formal and informal institutions: they are regularised patterns of behaviour structured by rules which have widespread use in society. They mediate the processes through which livelihoods are constructed. They may, but do not necessarily, reveal themselves through identifiable groups of people. Examples would include rules governing common property resources by which clan members are expected to abide and the patterns of behaviour around such resources.[20]

The way that decisions around natural resource management are made, in relation to all the strategies including agricultural intensification, and the effects of institutions (such as land tenure and labour arrangements) on these decisions is critical. Institutions may either facilitate a decision for an individual or household to intensify (for example institutional arrangements within a lineage may enable someone to borrow livestock from a lineage member to get the benefits of manure), or may make such a strategy impossible by being exclusive (for example by excluding women from being able to borrow livestock) (See Ostrom 1990). Consideration needs to be given to a) whether existing institutions encourage or discourage the process of agricultural intensification; and b) the extent to which institutions are flexible and can change sufficiently fast to facilitate changes to intensification in response to changing relative factor scarcity. The types of institutions likely to be of interest include land tenure arrangements, labour contracts and arrangements that enable access to credit (through formal or informal institutions). This section will pursue one of these, land tenure, as an example of the institutional approach.

The work of Turner *et al.*, has confirmed the significance of supportive socio-economic organisations and structures in ensuring sustainable agricultural intensification. In particular their case studies of Jos Plateau (Nigeria) and Kisii (Kenya) illustrate the generally positive impacts on agricultural growth and economic diversification when resource-allocation rules, government policy, and functioning factor markets favour agriculture. Of particular importance are flexible local tenure rules and arrangements in supporting the growth of farms in size and number. They note that land improvements are facilitated by security in tenure, along with factor markets that provide outlets for production and marketing arrangements that provide for reasonable producer prices. They observe that 'most examples of sustained food production and well being involve some move into market cultivation of some kind and economic diversification' (p. 413) and argue that a neoliberal policy framework promotes markets under conditions of lessened control. Their studies highlight the significance of flexibility in allowing the positive aspects of economic diversification and marketing to be balanced with needs and demands of subsistence of the African farmer. They emphasise the need for flexibility as customary rules for resource allocation and household security, circumstances of households, options for intensification, marketing and diversification differ throughout Africa.

On the flip side of the coin Turner *et al.* note that the key constraints to intensification (in addition to technical limitation and inadequate market development) are inappropriate customary resource allocation

rules. They note that the rules of resource allocation can become a constraint to agricultural growth in situations where change is very rapid, and the needs relating to promoting agricultural growth come into conflict with objectives of allocation rules. While suggesting that the land tenure situation is complex, some of Turner *et al.*'s case studies confirm the resilience of indigenous land-tenure institutions as observed by Downs and Reyna (1988) and suggest that many Africans are at a turning point with their relationship to their land. Land is no longer a free good, and access to it is becoming increasingly restricted with some people acquiring large amounts while others are losing what little they had. They observe that day-to-day decisions are increasingly being made by women, while at the same time access to land is invested in males. They argue that 'land tenure must be considered a key institutional factor in agricultural development in SSA.' (1993: 418).

State interventions to alter patterns of land control have been problematic (Kenya in the 1950s, attempts to adjudicate and register ownership; and attempts in Tanzania in the 1970s at introduce collective tenure at a village level), and it has been shown that access to resources depends as much on non-market criteria. Membership of social networks, (Berry 1984 and 1993; Shipton and Goheen 1992; Downs and Reyna 199; Bassett and Crummey 1993) and the influence of customary law (Mann and Roberts 1991; Colson 1971; Moore 1986; Okoth Ogendo 1989) are critical to peoples access to, and control over, land and other natural resources. For example the establishment and reaffirmation of 'advantageous connections' within acceptable social formations and the incorporation of systems of multiple rights, may enable access to resources in situations of high population pressure. (See Hyden 1980; Shipton 1988). Attempts by local communities to cope with these tensions related to increasing population pressure may be important in determining changes to rules of access to land resources. Thus, Turner *et al.* argue that population growth may be effective in changing land tenure patterns (1993: 419-20).

There is a debate around the question of whether tenure security is a necessary condition for intensification.[21] Some have argued that indigenous land tenure is dynamic and evolves in response to factor price changes (Boserup 1981; Turner *et al.* 1993). Thus the commercialisation of agriculture and population pressure result in the privatisation of land rights. Others argue that indigenous land tenure is static and provides insufficient security to induce farmers to invest in land. It has been argued that tenure security results in an increase in credit use, increased transactions in land (ensuring that those with the capabilities of improving productivity do gain access to land), reduced land disputes and increased agricultural investment resulting in greater productivity (Feder *et al.* 1988; Barrows and Roth 1990). According to Barrows and Roth (1990: 298) 'even given the existence of various favourable conditions, the institutions governing control of land can constrain development if inflexible rules of tenure prevent movement of resources among individuals, or if tenure insecurity lowers investment demand.' Such arguments have led to the endorsement by international agencies (World Bank 1974) of the promotion of freehold tenure with title registration.

The relationship between indigenous tenure arrangements and agricultural production in Sub Saharan Africa has been tested by Place and Hazell (1993) using econometric modelling. They examined data from

rain-fed areas of Rwanda, Ghana and Kenya to test whether land rights have a significant effect on the use of credit, input use, land improvements and yields. They concluded that the rights that farmers held over specific land parcels varied considerably in the regions studied and were 'in many cases surprisingly privatized' Their results suggest that 'with few exceptions, land rights were not found to be a significant factor in determining whether of not farmers made land-improving investments or used yield enhancing inputs'. (1993: 16-19) Neither the use of formal credit nor yields were found to be significantly related to land rights in any study region. The reason for this latter point, they suggest, is likely to be that there are other more binding constraints on agricultural productivity such as lack of improved techniques or inadequate access to credit. Their study therefore gives little support to registration and titling programmes. They acknowledge that such programmes might increase productivity in situations where the absence of privatised and more secure land rights is a deterrent to intensification decisions but their data suggests that even where all land has been titled customary restrictions on land rights still prevail. Furthermore, their results suggest that even if land rights could be changed, they may not affect productivity if there are more binding constraints. Such findings, that land rights do not significantly determine whether farmers invest in their land, have led to calls for more 'gradualist' approaches to tenure reform with an 'adaption paradigm' in place of the 'replacement paradigm' (Bruce and Migot-Adholla 1994 and Migot-Adholla *et al.*. 1991).

McNicoll and Cain (1989: 3) have also called for greater understanding of society's institutional structure by which they mean 'society specific patterns of social organisation and the rules and routines of economic and political behaviour.' The institutional effects in production relations they discuss include property and labour relations, family patterns, community organisations and government administration, thus taking in institutions at a range of scales. Using studies from Indonesia, Bangladesh and Kenya they illustrate the significance of an number of institutional variables (family, community and government) to population-rural development interactions. According to McNicoll and Cain the policy implications of 'recognising the historical layerings of institutions forms and their economic and cultural supports that make up the organisation of any complex society' are that 'policy designs will not be readily transferable among settings' (1989: 40). They argue that 'under certain configurations of [pre-exiting institutional structures], population growth induces productivity improvements that accommodate or feedback effects that tend to restrain that growth. Under other configurations, perhaps once equally `satisfactory' in meeting societal needs, no such responses are generated.' (Cain and McNicoll 1988: 101). The role played by 'adverse institutional features' in situations where the poor have lost out from technical changes and commercialisation of agriculture has been observed (Binswanger and von Braun 1991).

Using evidence from Asia and Africa, Pingali (1990) examines the institutional and environmental constraints to successful agricultural intensification. He notes that while most societies have responded to population growth and/or increased market demand by intensifying their agricultural systems, (with associated changes in technologies and institutions) there are several examples of failures. He argues that these failures in agricultural intensification can be attributed to one or two of the following reasons:

persistence of uncertain long term rights to land; encroachment of cultivation on marginal lands; and collective effort required for watershed-level protective measures.

Binswanger and McIntire (1987) examine the logical consequences of population growth for production relations, tracing the evolution of factor and output markets. (For example as population increases land acquires a scarcity value, and can be used as a collateral, which in turn increases the supply of credit.) They interpret institutional arrangements as locally efficient ways of coping with risk and transaction costs under the given production conditions. Population growth alters those conditions (by changing factor proportions, scale effects etc.) and in turn gives rise to different risks and transaction costs which may make an alternative institutional arrangement more efficient.[22] A number of studies have been carried out to examine how institutions change or evolve in this way and these confirm that access to resources through social networks, and the evolution of social institutions in response to changing factor ratios, are crucial.[23]

In the case of Machakos, Tiffen *et al.* (1994) examine the institutions such as those of 'family, mutual help groups, markets and local community leadership... missions, Government and commercial organisations.' They note that the new and old are now interwoven and 'society has become more complex, with new specialised institutions to facilitate the processing of knowledge, the adoption of innovations and the ease of transactions. ... Economic development therefore reflects not merely what is happening to the average farmer, but also growth in the capacity of social institutions.' (1994: 131).

They conclude that there has been 'an expansion in the number and complexity of institutions which convey and process knowledge or capital, or which allow manipulation of the changing economic and political situation, through a broadening of the leadership base at village level.' (1994: 152-3) This has also meant an enlargement of the pool of talent for a society to draw upon - from one once dominated to male patriarchs, to one that now includes women, younger educated people, traders etc. Government is also now seen as part of society, and people know how to communicate with it. People feel more able to pool knowledge, capital and labour than in the past. Other means of drawing on resources and expertise include through the churches, coops and NGOs. The family is still an important economic unit, through which knowledge and capital flow between those in farm, and those in non-farm activities. Self-help groups have developed, and have been particularly important in providing women with a chance to become leaders at village levels. Thus, the area has been particularly fortunate in the way that traditional mutual-assistance groups have survived to take new forms.

In conclusion, it is clear that the path that agricultural intensification follows is dependent on a number of factors including agroecological environment, level of returns in the face of risk and uncertainty, policy environment, agricultural research facilities, access to technology, information etc. Furthermore, consideration needs to be given to the institutional factors which might help to explain the conjuncture that enables sustainable agricultural intensification. It is apparent that the institutions specific to each location, the way that these institutions mediate agricultural change and longer-term historical factors which have influenced these institutions are critical. It the aim of the Sustainable Livelihoods Programme to gain a

greater understanding of these.

NOTES

1. For further details see SLP mimeo. (Feb. 1997).
2. An alternative to AI is extensification: that is the expansion of cultivated area into previously uncultivated areas. It may require increased inputs (e.g. construction of irrigation channels or drainage of swamps) and therefore increased labour demands. However, it will be extensification (not intensification) so long as the ratio of inputs of labour/capital to land do not increase.
3. Fertiliser and irrigation will usually, although not necessarily, involve more labour or capital.
4. Those processes associated with AI that are related to crop-livestock interactions (animal traction, use of manure etc.) are dealt with in further detail by Will Wolmer in his SLP Working Paper.
5. Smaller farms give rise to lower labour transaction costs, and therefore higher labour input per hectare, and so AI.
6. Studies illustrating the problems associated with irrigation include: Perera, Sri Lanka (1987); Pinstrup Andersen and Pandya-Lorch - re environmental problems associated with irrigation, pesticides and fertilisers in Pakistan (1994); Environmental problems associated with irrigation in Asia see Rosegrant and Livernash (1996); Biswas (1995) study re the sustainability of AI and irrigation in Egypt; Walderstein (1978) critical of large scale irrigation in the Sahel.
7. See for example De Wilde. The two African schemes often quoted as successes are Gezira and Mwea. The former has inspired further irrigation schemes in SSA but has experienced problems associated with over use of pesticides and health related problems for the population living in the area. The latter scheme encountered difficulties in finding a profitable crop and while one had been found (rice) and the scheme does not require subsidies to cover the running costs, the area has experienced problems of low incomes and malnutrition amongst children. (Adams 1992.)
8. For an examination of why mechanised agriculture has been so slow to spread in SSA see Pingali, Bigot and Binswanger (1987).
9. For comparison of AI driven by population growth and AI driven by policy interventions and market forces in Northern Guinea see Freeman (1994) and Freeman and Smith (1996).
10. For further discussion of policy reform see Ahmed and Lipton (1997).
11. Also see Courade (1994) re Cameroon.
12. Malthus pre-empted Boserup as in his model any extra income, due to Boserupian intensification, would merely set population growth off again. For further discussion see Lipton (1989).
13. See for example Ehrlich (1990) and Brown (1985).
14. See Turner *et al*, (1993) for case studies of high density population areas which examine how intensity of agriculture has changed, how these changes came about and the consequences of such changes.
15. For further details of Boserupian and Hayami-Ruttan-Binswanger models see Lipton (1989).
16. Also see Berry (1984).

17. For Africa see for example Goldman (1993); Mortimore (1993); Tiffen *et al* (1994); and for India Goldman, (1995).
18. Furthermore, it is also noteworthy that Machakos is exceptional in its proximity to a large market (both for produce and for labour) in the form of Nairobi.
19. His emphasis.
20. For further discussion see Defining Sustainable Livelihoods, Feb. 1997.
21. See for example Downs and Reyna (1988);. Bassett and Crummey (1993); Atwood (1990); Barrows and Roth (1990). For discussion of so-called "evolutionary" process in the development of land tenure (increasing population and integration with the market resulting in a move towards individualisation) see Platteau *et al* (1996) and Platteau (1991).
22. Also see Ruttan (1978); Ruttan and Thirtle (1989).
23. See for example Dellere and Symoens (1991); Patten and Nukunya (1982); Riddell and Campbell (1986); Snyder (1996); Stone, Netting and Stone (1990) and Stone, Stone and Netting (1995).

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