As pointed by Kevane (1992), we can conceptualise subsistence households in the study area as attempting to move towards an optimal resource allocation position in cultivation by adjusting their endowments through factor market transactions. Thus, on this ground alone, it is difficult to accept the notion of uncaptured peasantry. Hence, we will proceed with the first line of reasoning.

Eviction occurs before the introduction of the technology, proletarianisation occurs after the introduction of the technology. If one is to maintain the separation of the two effects, following Binswanger and Braun (1991), eviction implies failure of policy and not failure of technology. Hence it could be hypothesised that; pressure on land is not due to increased demand for subsistence needs, but mainly due to unwarranted expansion of commercial agricultural production. It follows that intensification of the frequency of land use for a given agricultural practice, is a direct result of bad commercialisation policies. In this case subsistence farmers become users of the marginal land and need more labour for direct production and for transport, to maintain the old level of subsistence, thus implying that eviction represents a push towards greater subsistence.

If the intensification of land use is interpreted in a neo-classical sense, then, farmers with a low land/labour ratio will end up with high land/labour ratio (through the use of more land of poor quality, for example). Thus it may be hypothesised that variation in land/labour ratio in different locations is significantly explained by land quality alone (different degree of fertility), rather than by other factors such as assets holding, observing the right time for inputs application, etc. If this is supported by data, then land reform, in the sense of redistribution of land from the mechanised farming sector to the subsistence sector, does make sense.

If proletarianisation means selling more labour to the mechanised farming sector, then we hypothesise that for each household, this labour:

i. is drawn from the previously under-utilised labour augmented further by the reduction of the subsistence ratio;

ii. is drawn from labour previously committed to own farm.

The rest of the study is organised as follows: chapter two outlines the theoretical framework; it also points to the research methodology, the sampling procedure and to the source of the data that forms the basis of our analysis. Chapter three discusses the main results; it also describes labour time use, especially the determinant of off-farm agricultural work, the determinants of labour productivity and productivity of time. Chapter four provides the main conclusions and their policy implications.

2. THEORETICAL FRAMEWORK, DESIGN OF THE SURVEY AND SAMPLING PROCEDURE

2.1 Theoretical Framework: Towards a Simple Model of Household Economy

From the outset, at one stage, the effects of technological change and commercialisation of agriculture on production, income and employment take many different forms. The gainer-loser situation is very intricate because the flow of resources among households, between them and outsiders is an on-going process. At another stage, the subsistence
household itself is a production and consumption unit, and what is produced, consumed or exchanged through market transaction constitutes, on a micro level, a resource flow system also involving gainers and losers. Thus the complexity of the relationships involved in the process of technological change and commercialisation suggests that a comprehensive model of the household would be helpful in deriving testable hypotheses. No such model of peasant behaviour is advanced here nor are we enthusiastic about reproducing some of the established models. However, a very brief summary of these models relevant to our purpose may be suitable.

2.1.1 A Review of Household Theory

The process of the transition from subsistence economy towards a market integrated one is usually analysed in terms of models based on the theory of subjective household equilibrium developed by Chayanov (1956). According to him the subjective equilibrium of household is an outcome of equality between demand satisfaction and drudgery of labour. Chayanov's contribution lies in the claimed link between labour input of the household and its producer/consumer ratio. He advanced this thesis of demographic differentiation in contrast to Lenin's thesis of social differentiation.

The work of Mellor (1962), Sen (1966) and Nakajima (1969) stimulated by Chayanov has been placed amongst the most sophisticated systems of analysis of the subjective equilibrium of peasant type farms. Their main concern is with the problem of peasant participation in advancing the "monetized enterprise" via cash cropping or wage labour or both. This work has been criticised in the literature for modelling this transition at the level of resource use without explicit account of the underlying causal links, such as risk aversion, that may push peasants to maintain a certain degree of self-sufficiency even at the cost of market income foregone.

Fisk (1975) assumes a complete separation of a subsistence enterprise and a monetized enterprise and then explicitly account for the underlying dynamic forces that reduce the high marginal utility of subsistence production namely the appearance of effective rural market, changes in household preferences and production technology. However, the appearance of a unique monetized enterprise is still a 'hot' debatable issue (von Braun et al. 1991).

Since Becker (1965), models based on joint utility approach are used to model semi-commercialised households, which are assumed to maximise an exogenously given joint utility function. Production and consumption decisions are integrated within the household which optimises amongst its choice of consumer goods as well as its supply of labour to the market and to household own farm. An important assumption in these models is the full co-operation between the members of the household. Another version of these models based on the bargaining approach, associated with the neo-classical game theorists and the feminist writers, is used to model explicitly the intra-household conflicts.

In general, studies on the dynamics of rural change in the LDCs usually concern themselves with the nature of the interactions between the farm and non-farm enterprises. The backward and forward linkages have been the focus of these studies (ILO 1974; Mellor and Lee 1973; Adelman and Taylor 1991; Dorosh and Haggblade
1993). In most of the cases the findings of these researches give support to Hirschman’s (1958) view that agriculture usually generates much less stimulus than manufacturing to the production in other sectors.

This study attempts to identify subsistence household’s links to the mechanised farms subsector, which is expected to have substantial consumption linkages that set in motion employment and income effects. In particular, the study seeks to sharpen our understanding of the manner in which these sequences of employment and income affect the pattern of household’s subsistence orientation in production.

Ideally, recursive programming models should be used in a view to capture the dynamic path of these economic outcomes. How well these models perform depends upon their abilities to capture the historical trends for the variables of interest over the period for which the models are estimated. Detailed time series data of the sort needed to test such complex models is not available nor are there detailed dynamic microeconomic studies in Sudan that can be used to direct such data gathering activities. However, even if time series data is available, inter-temporal comparison of households’ attributes may cause complications because of the changes over time in the composition of the household in the rural category. For example, Buatista (1994) pointed that a particular community might be initially classified as rural, but as it becomes more progressive the same household may be graduated to the urban category.

This study uses spatial cross-sectional data, first, to highlight the fundamental character of the spatial structure and the extent to which this character is explained by the interaction of the agricultural and non-agricultural activities. Second, it uses a set of identities and multivariate analyses in an attempt to quantify two sources of household income: production of farm or household enterprise and wage employment. The first source requires time inputs of household members, productive assets such as land, agricultural and other implements, technical know-how and intermediate products such as machine power, seeds, etc. The second, earnings, depends on the amount of time the household sells in the labour market, and the wage rate that each unit of time commands.

Before addressing the major research issues, we will point out three simultaneous relationships that present us with some basic analytical problems. First, as households in the case study are assumed to maximise their welfare, the level of income generated through work and the level of leisure are co-determined. Secondly, in a dynamic setting, the productive assets that determine the level of income stem from savings, which in turn depend upon past incomes. Thirdly, household size and demographic cycle determine the household’s labour endowment and hence its income. Thus, over time and space some basic socio-economic outcomes (allocation of time, income and endowment of human and non-human assets) are determined in a way in which cause and effect are not easy to establish.

Having noted the above, for analytical and empirical reasons we state the following assumptions:

i. Particular socio-economic circumstances and phenomena are not outcomes of household decision-making in the short run, but they are the ultimate determinants of the particular outcomes at which we look.
Households in the case study area seek to maximise total income in any year.

The resources available to households are limited and fully employed. These inputs are labour and capital.

Land is not a major constraint in production.

Capital and population remain the same.

2.1.2 The Analytical Approach

In order to highlight the differences in levels of relative socio-economic development the technique of factor analysis will be applied to a large number of indices representing more or less the socio-economic structure of the surveyed locations ranked by size of population with the view to find out whether or not there is any underlying pattern of variations among the selected indices, and whether or not places tend to group on dimensions representing these patterns. We follow Berry (1962) in that, when the data reveals a fundamental character of spatial structure on a continuum of relative development, then movement along this scale will be interpreted to represent changes in these indices viewed overtime. Multivariate analyses will be used to study the interaction of interest. We start with the following identities that describe household’s resource endowment and subsistence orientation in production and consumption.

2.1.3 The Identities

For each household, aggregate labour time supplied in the course of an agricultural season is given by:

\[(\text{Totlab})_i = (\text{Labof})_i + (\text{Labmf})_i + (\text{Labnon})_i \ldots (1)\]

where,

\[\text{Totlab} = \text{total available labour force in days/year per household measured in adult equivalent.}\]
\[\text{Labof} = \text{household labour, in adult-equivalent allocated to own farm.}\]
\[\text{Labmf} = \text{total labour time sale to mechanised farms sector in days/year per household, measured in adult-equivalent.}\]
\[\text{Labnon} = \text{total labour time spent on unorganised household activities measured in adult equivalent.}\]

For all households:

(a) The agricultural subsistence orientation is measured by the ratio:

\[\text{AS} = \frac{\text{NM}}{\text{AP}} \ldots (2)\]

Where:

\[\text{AS} = \text{the agricultural subsistence ratio.}\]
\[\text{NM} = \text{the value of non-marketed agricultural produce.}\]
(b) Subsistence orientation in consumption is measured by the ratio:

\[ \frac{C}{C_t} = \frac{\text{the subsistence share in total consumption}}{\text{total value of goods consumed in the household including purchased and own production items}} \]

Where:

- \( C \) = the subsistence share in total consumption.
- \( C_t \) = total value of goods consumed in the household including purchased and own production items. That is, \( C \) equals the share of the value of own produced food consumed by the household in total value of food and non-food consumption.

Identity (2) and (3) refer to two concepts for subsistence orientation relating to the effects of the technological change and commercialisation (von Braun et al. 1991). In our case the first concept captures the output effect (cases where households grow more cash crops). The second concept captures the input effect (cases where households sell more labour to the mechanised farm sector).

### 2.1.4 Productivity of Time and Production Function

In light of our earlier discussion and in order to model the commodity side of the transition process, it may be important both to introduce the distinction between the subsistence and market production at the level of resource use, especially with respect to labour use, and to specify the underlying causal determinants such as risk aversion, task and habits that may motivate a household to maintain a certain degree of self-sufficiency even at the cost of market income foregone. Thus a common non-monetary utility index is useful.

Following the analytical framework suggested by Becker (1965), the household is assumed to ‘produce’ the attributes of its utility maximisation with input of time and goods, which are obtained through income. In determining the production function, an individual’s allocation of time to economic work will be viewed as a function of household’s assets, his own labour productivity together with other control variables. This production function is a good proxy for a non-monetary utility. The estimation of this function will distinguish this study from previous research in that it will derive a rough estimate of marginal productivity of work performed by relating time input into the production process to income generated by this work. This procedure is justified by the structural constraints prevailing in the study area. Unless it is assumed that factor markets are competitive and that the household optimises labour use by adjusting its labour endowments through labour market transaction, we expect labour productivity to depend largely on complementary resources available in the household enterprise (such as labour, know-how, assets, etc.).

For estimation purpose, a household’s income (\( R_{\text{prod}} \)) net of transfer, is assumed to be generated by a production function where age-group specific time (\( t^{12} \)), human capital and know-how (\( \text{Educacat} \)), net sown land (\( \text{lands} \)), value of cattle (\( \text{cattle} \)) and value of small animals (\( \text{small animals} \)) are inputs. Thus, the aggregate agricultural production function of households is assumed to be depicted by the following equation:
\[ R_{\text{prod}} = f(J_{1n}, \text{Educat}, \text{land}, \text{cattle}, \text{small animals} \sum D_i) \ldots (4) \]

Where:
\[ \sum D_i = \text{dummy for study location (I = 1, 2, ..., n; so that n = k - 1, where k = number of study locations).} \]

We hasten to note that income and time allocation are codetermined and hence simultaneity bias inherent in model 4 may lead to some underestimation of the time input coefficients. However, since we are interested in productivity of households which is supposed to reflect a substantial variation in earning opportunities, several versions of model 4 will be estimated. We first exclude income from wages and time spent on wage labour, rather than add wage income as part of income and wage labour, as part of time input and re-estimate the same model.

Our approach is as follows: first, we calculate the marginal productivity of labour based on the estimation results of each version of model 4 as applied to different groups of households classified by asset holding, model of land acquisition and gender composition of the household. We use these coefficients to gain information about age-group specific time allocation, and about the adequacy of the utilisation of rural labour supply. Evidence of low productivity and long hours of leisure will be interpreted as indicators of possible existence of labour surplus. Second, we assume that labour productivity is predetermined, i.e., rural labour market is competitive and wage rate measures the output forgone in the subsistence sector. Hence, the variability in the household labour supplied to off-farm (offwork) is explained by function 5 below.

\[ (\text{Offwork}) = h (\text{Wage, Rprod}, \text{Eprod}, \text{Ecash}, \text{Yoff}, \text{Womensh}, \text{Malesh}) \ldots (5) \]

Where:
\[ \text{Wage} = \text{off-farm wage rate per day in Sudanese pounds (ILs).} \]
\[ \text{Rprod} = \text{net return in agriculture per available labour-day, an index for labour productivity.} \]
\[ \text{Eprod} = \text{Expected values of current cash crops in LS, based on last year's estimates.} \]
\[ \text{Ecash} = \text{Expected value of current cash crops in LS, based on last year's estimates.} \]
\[ \text{Yoff} = \text{Cash incomes from other sources in LS.} \]
\[ \text{Womensh} = \text{The share of women in the household among adult labour force, gender composition of the household.} \]
\[ \text{Malesh} = \text{The share of male adult in total persons in the household.} \]

The relation between (offwork) and wage is always positive. We note that the conversion of the subsistence household in wage labour through proletarianisation or through eviction and displacement by machine will be envisaged if the supply of labour to own-farm and to the mechanised farms is mutually exclusive and there is full employment in the subsistence sector; there is no way to shift the season by changing the crop mix. The
The coefficient of $R_{\text{prodi}}$ is expected to reflect the effect of agricultural labour productivity on the allocation of off-farm labour. We expect a negative relation. Also the coefficient of $E_{\text{prod}}$, $E_{\text{cash}}$ and $E_{\text{off}}$ are expected to be negative. A household with high women share is expected to supply less labour to off-farm employment market; hence we expect a negative co-efficient for $W_{\text{omensh}}$. Conversely, a household with high adult share supplies more labour and hence the coefficient of $M_{\text{alesh}}$ is expected to be positive.

Based on (4) and (5) above, we shall run two regressions to test the following hypotheses:

i) Labour intensification hypothesis:

\[(\text{Lab}_{\text{m/f}}/\text{Totlab}) = \beta_0 + \beta_1 (\text{Totlab}/\text{Adult}) + \varepsilon \ldots (6)\]

Where:

$\text{Adult} = \text{number of adults per household}; \text{the rest of the variables are defined as before and } \varepsilon \text{ is an error term.}$

We test:

$H_0: \beta_1 = 0 \text{ against } H_1: \beta_1 > 0$.

If $H_1$ is accepted, then labour intensification would be upheld. That is, the supply of labour to off-farm employment market, mainly in the mechanised farming sector, is tapped from the under-utilised peasant labour by increasing the hours worked per adult.

ii) Inverse labour hypothesis:

\[(\text{Lab}_{\text{m/f}}/\text{Totlab}) = \alpha_0 + \alpha_1 (\text{Labof}/R) + \varepsilon \ldots (7)\]

Where:

$R = (\text{Labof} + \text{Labnon}), \varepsilon \text{ is an error term and the rest of the variables are defined as before.}$

We test:

$H_0: \alpha_1 = 0 \text{ against } H_1: \alpha_1 < 0$.

If $H_1$ is accepted, then supply of labour to the mechanised farms sector and to the family farms as well as to non-farm activities is competitive, i.e., the proletarianisation thesis would be upheld.

The information gained by testing the two hypotheses by itself is not sufficient to establish the labour intensification and/or the inverse labour supply. To fully evaluate the two hypotheses, we need information on the labour augmenting effect of the mechanised farming sector that works through the food crops market and eventually reduces subsistence orientation in production. This point is formalised below.
2.1.5 Subsistence Orientation in Consumption

Consumption ranks high in the household decisions about subsistence orientation in production. In specifying this relationship it is hypothesised that first, the availability of the production resources determine the production and income earning capacity of household, and hence, the degree of subsistence orientation. We propose the use of the share of adult in total number of persons in the household as an index for productive resources. Secondly, we hypothesise that household per capita stock is necessarily related to subsistence orientation. Thirdly, we hypothesise that an increase in production and/or productivity in the mechanised farms reduce the price of the subsistence good (dura) and thus reduce subsistence orientation in household production. Farmers will gain as consumers at least in the short run and hence tend to diversify their resources out of subsistence production. In this case possible gains from policies designed to depress the price of agricultural staple in the local market eventually trickle down via the food crop market to the subsistence households. Hence, we hypothesise that expected reduction in the prices of dura reduces subsistence orientation. Fourthly, live-cycle of the household influences subsistence orientation. Finally, household’s perception of risk influence subsistence-orientation, a subjective valuation of risk based on the head of the household views will be included. Using identity (3) we specify the following equation:

\[ C = G (\text{Adultsh}, \text{Capital}, \text{Eprice}, \text{Childsh}, \text{Irisk Wage}, \text{Rprod}) \quad \ldots \quad (8) \]

Where:

- \( C \) is a percentage change in subsistence orientation as defined in (3);
- \( \text{Adultsh} \) is the share of adult in total persons in the household;
- \( \text{Capital} \) is the household per capita stock;
- \( \text{Eprice} \) is the household’s expectation of the prices of dura in the local market. (Locational differences and seasonal variations of the price of dura were captured by the survey at the household level).
- \( \text{Childsh} \) is the share of non-producing members, (the dependency ratio);
- \( \text{Irisk} \) is an index of risk based on the head of household perception of crop specific risk on scale of 1 to 3. (The rest of variables are defined as before.)

Equation 8 will be estimated for all households groups. In cases where \( C \) is significantly explained by \( \text{Eprice} \), and where one or both of the alternative hypotheses is/are accepted, the situation of vulnerability among households should be explained in terms of inefficient specialisation.

2.2 Design of the Survey and Sampling Procedure

The investigation of the research questions is based on a data set drawn from southern Kordofan region. Two techniques were used for data collection: direct observation and questionnaire.
2.2.1 The Study Area

The study concerns itself particularly with highly dynamic Southern Kordofan prefecture. Over 90% of the population of the region are engaged in agriculture and all the food requirements for the people in the region are more or less produced in this sector (Falalla et al. 1982). The distinguishing feature of the agricultural practice in the area is the co-existence of family farms and the mechanised farms. The former denotes an agricultural social mode of production where household labour is the major input. Land ownership is communal whereby every household has unrestricted rights to parcel(s) cleared by household labour, which is the main determinant of production. The main food crop grown is dura. Other cash crops include sesame and groundnut. Production in the household enterprise is not a closed system. Due to the technological penetration and the growing market integration, hiring of labour is observed; the degree of this penetration, and what population group is affected most (men, women) remains to be determined. The latter, the mechanised farming sector, is a system of crop production which is run on commercial basis. Land is leased by individual investors whereby each individual is allotted a farm and deep disc harrows are used. The organisation of production involves interaction between three social groups: farm owners, resident farm managers (wakeels), and seasonal agricultural labour.

We drew from the central place models to form the study area. However, the hierarchical order is dictated by the patterns of human settlement in the area. First, we selected three intermediate urban centres at the higher rank of this hierarchy. Second, four locations were selected on the basis of their proximity to the mechanised farms, and the level of development of local markets. These four locations correspond to four central villages (or non-mobile markets). They are also sites for government offices serving a large number of smaller villages in their immediate envelope. Finally, 18 small villages were selected. Thus, the reasons for selecting the research site are: i) The rapidly developing institutional links, in particular markets and government offices, in the area especially after the encroachment of the southern war on the former site of mechanised schemes as we will see in section 3.1; ii) As a result of these adjustments the area has become highly dynamic where economic change is occurring rapidly (figure 2 below shows the surveyed centres).
Fig. 2. Study Area and the Surveyed Centres
We identified 13 characteristics representing the socio-economic structure of the three broad ranks of the selected study areas. Although these places vary in size, function and locational characteristics, the procedure for defining the characteristics is based on quantitative and qualitative data and is almost similar for the three orders of places. The included characteristics depict important aspects of rural change associated more or less with the rise of the mechanised farms. More than one indicator is used in defining the characteristic of a place. Then with a blend of survey data and judgment the places were classified according to these characteristics. The data matrix is obtained by ranking the 25 places on each of the 13 socio-economic characteristics using a simple linear scale. For example, the highest score (90) is assigned to a place that ranks high and 10 to a place that comes lowest in rank with respect to each characteristic. The intermediate classifications are scored at equivalent intervals between 90 and 10.

2.2.2 Limitations of the Data

We carried out one round survey to generate our data. But this method presented us with the problem of studying variation overtime. However, the problem of the timelessness of the data will be circumvented since we are using cross-section data. Unfortunately, there are no detailed records of time series data that can be used to study the dynamic path of the economic variables of interest. However, to present the reader with an idea of the dynamics of change overtime in the study area, first we determine the factor solution to the data matrix recovered from the central place schedule with a view to identifying the characteristics associated with mechanisms of change. Second, dummy variables were used to control differences of the broad spatial characteristics.

It is our contention that the diversity of a country such as Sudan cannot be captured by researching the micro-level processes of tractorisation and commercialisation for just a few locations over a short period of time. However, these observed processes are not unique to the case study area. Because of many standardised features of the Sudanese dry agriculture, the case study area has much in common with other sites of rain-fed agriculture. Hence, it could be argued that the conclusions established using the data generated from the study locations can be generalised without altering the underlying theoretical premises on which they are based.

3. PRODUCTION, CONSUMPTION AND INCOME EFFECTS OF TRACTORISATION AND COMMERCIALISATION PROCESSES

The tractorisation and the attendant commercialisation processes in southern Kordofan manifest themselves in the changing income sources of the household and in changing the patterns of household labour use. These processes occur partly on the basis of indigenous source of off-farm employment, cash crop production and collection of wild edible fruits. The increased off-farm employment generated by the mechanised farm schemes in the community has acquired increased importance. Before tracing in detail some of the issues raised earlier, background information at the regional and community levels on the rise and the role of the mechanised farms is provided below.