Workshop 1

Key Factors For Future Research In Land Resource Management – The Case Of Farming Systems In The Savannah Of Brazil

Philipp Grundmann
(Universität Hohenheim, Institut 490 C; Fruwirthstr.12, 70593 Stuttgart, Germany;
grundman@uni-hohenheim.de)

Abstract

The occupation of the best suited land for agriculture and the degradation of cultivated land are increasing the pressure on the remaining unused areas and adjacent ecosystems world-wide. The need for a reorganisation of social, environmental, technological and land policies becomes evident. A comprehensive development strategy has to be based on a sound understanding of the factors that influence land resources management. Therefore, the overall objective of this study is to generate basic knowledge about these factors that need to be given special attention in future research, considering the case of the Brazilian Savannah.

The first question dealt with is to what degree the motivation of farm families to stay or to move from their land is determined by the availability of land. The importance of this relation becomes clear, when considering that the long term motivation of farm families will also influence the use of the resource land in a sustainable or unsustainable way. The question is also raised whether it is possible to fix the families by improving their living standard alone. Some related questions are, whether the regularisation of land ownership as a precondition to fix the farm families on their land, and a more equal redistribution of the resource land and of other related resources like education and credits, have an impact on land resource management strategies and the promotion of soil conservation measures, as well as intensification of farming systems, that are of increasing importance in solving the land scarcity problem. Some alternative strategies of farm families to overcome land scarcity are presented as well. Finally, the strategy of creating off-farm employment possibilities is analysed as a way to reduce the pressure on the remaining areas.

Introduction

The reasons for the increasing scarcity of the resource land can be manifold, ranging from the increase of the rural population, the migration of population into new areas, the reduction of soil fertility of used land and to the loss of productive land through irreversible degradation processes. The consequences generally observed range from the reduction of the farm income, an increasing intensification of production, the adoption of resource conservation technologies, increasing conflicts between the goals of intensification and stability of the farming systems, an increasing potential for social conflicts, to increasing land prices, all of which may finally urge the rural population to find new income sources outside farming or even lead to the migration of the families (Doppler, 1997). These mainly negative consequences are increasing the preoccupation of the rural and the world community about issues related to the management of the resource land. In this study some basic aspects are analysed that need to be considered in any strategy that aims to overcome the important limitation of land scarcity, here for the case of the Brazilian Savannah.

Study design and data

To study the dynamics of farming systems, this research followed the farming systems approaches of Doppler (1994), with mayor emphasis on the “Farming Systems Analysis“. Information for this study was collected at micro, municipality, state and regional levels. Therefore, six different study areas were chosen to collect information with standardised

questionnaires at family-household level in the agricultural year 1997-98. All study areas were particularly selected as being representative of the region studied, because (1) the areas are located on the plain areas, in the valleys and in hilly areas respectively, which is similar to the predominant topography of the whole savannah region, (2) agricultural activities being carried-out in these areas include all important land use systems to be found in the studied region (3) each area has suffered a particular occupation pattern representing the different variations of the expansion process of farming observed in the region as a whole (4) the areas are distributed all over the studied region reflecting the different conditions and possibilities offered to farmers in the different administrative and political settings. The total sample size was 190 farms. After completing the field survey, data from questionnaires were entered into database software (EXCEL 97) for a data bank design. Thereafter the transferred data was tested for reliability mainly by visual checking and some statistical controls. Then, the extreme values and wrong answers were addressed. Next, the calculation of the first parameters was accomplished by the help EXCEL 97. Thereafter the main groups of farming systems were classified resulting in two study areas with predominantly large scale mechanised farming systems in the States of Minas Gerais (Pantaninho Study Area) and Mato Grosso (Lucas do Rio Verde Study Area), two study areas with small scale agricultural farming systems the States of Minas Gerais (Iraí de Minas Study Area) and Mato Grosso (Jaurú Valley Study Area), one study area with mixed farms at the forest margins the State of Mato Grosso (Sinop Study Area) and one study area with ranches in the State of Tocantins (Araguaína Study Area). The data from the study areas in Minas Gerais and the forest margins were taken from Santacoloma (2000) and Dörner (1999), respectively. A limitation in the study is the heterogeneity of the data collected from different authors in qualitative and quantitative terms. Therefore, where data was missing or incomplete the respective farming system was not included in the analyses. Statistical analysis was done using the WINSTAT and SPSS programmes. For the European reader it may be of interest to know that monetary values are presented in the Brazilian currency Reais (R$), which in the survey year was equivalent to 1.00 R$ = 0.82 Euro.

Land occupation and land availability

In the past the land-use pattern in the Brazilian savannah region was clearly divided geographically between the forest areas, used by smallholders to grow subsistence crops, and the areas with less dense vegetation formations, occupied by cattle-raising estates. Such land use features also protected the ecosystem from the more intense use of natural resources (Mueller, 1995). As the topographic conditions are quite differentiated between the locations of the different farming systems, obviously large scale systems are more favoured to agriculture mechanisation than smallholding systems and ranches (table 1). Instead of promoting an equitable redistribution of land, the government opted for encouraging large landholders to use their land in a more productive way (Mueller, 1995).

Table 1: Slope of land in different farming systems in the savannah of Brazil, 1997-98

Slope (%)	Large Scale Farms Pantaninho (MG)	Large Scale Farms Lucas do Rio Verde (MT)	Forest Margin Farms Sinop (MT)	Smallholdings Iraí de Minas (MG)	Smallholdings Jaurú Valley (MT)	Ranch Araguaína (TO)
0 – 3	10%	39 %	-	0%	0 %	0%
3 – 10	90%	61 %	100%	14%	29 %	44 %
10 – 18	0%	0%	-	86%	51 %	56 %
> 18	0%	0%	-	0%	20 %	0%

The inequality of the distribution of the land between the different farming systems as well as among farms of the same system category in the study areas is shown in table 2. Due to increasing income expectations that results from an increased availability of land, the factor farm size is very influential in decision making about land resources management.

Table 2: Average of farm sizes, farm and family income of different farming systems in the savannah of Brazil, 1997-98

Items	Large Scale Farms Pantaninho (MG) (n=29)	Large Scale Farms Lucas do Rio Verde (MT) (n=28)	Forest Margin Farms Sinop (MT) (n=25)	Smallholdings Iraí de Minas (MG) (n=35)	Smallholdings Jaurú Valley (MT) (n=41)	Ranch Araguaína (TO) (n=32)
Land size	564 (422)	5,576 (15,416)	913 (1,426)	65 (66)	72 (57)	6,550 (6,441)
Farm income (R$/family/year)	28,500 (108,398)	255,857 (517,218)	30,666 (84,140)	1,417 (5,696)	8,719 (14,761)	643,143 (857,109)
Family income (R$/family/year)	30,711 (108,765)	257,292 (517,631)	34,899 (83,961)	2,522 (5,461)	14,533 (13,447)	674,369 (860,659)

Figures in parentheses: standard deviations. n: the number of samples

Another major push factor that recently determined the occupation of new areas in the plains, as well as in the forest areas, was the scarcity of agricultural land in the traditional agricultural areas in the south of the country especially for highly mechanised large scale crop farmers and smallholders, while the ranchers had other motives to move into the region, mainly the availability of cheap land (table 3).

Table 3: Reasons for land acquisitions of different farming systems families in the past in the savannah of Brazil, 1997-98

Items*	Large Scale Farms Lucas do Rio Verde (MT)	Forest Margins Farms Sinop (MT)	Smallholdings Jaurú Valley (MT)	Ranches Araguaína (TO)
No land	10%	12%	32%	-
Land scarcity	68%	-	49%	-
Increase farm size	58%	56%	27%	-
Cheap land	19%	-	20%	75%
Land quality	23%	-	10%	-
Government incentives	19%	-	-	31%

* Only factors related to the resource land are presented here

The knowledge about the reasons of the families for acquiring new land is of great importance when making suggestions on how to reduce the pressure on the land by improving the living standard of farm families. The reasons given for land acquisitions in the past differ little from the reasons given for land acquisitions in the future, were economies of scale play a mayor role for large scale crop farmers, while for the other systems the reasons related to land scarcity and land degradation predominate (table 4).

Table 4: Reasons for land acquisitions of different farming systems families in the future in the savannah of Brazil, 1997-98

Items	Large Scale Farms Lucas do Rio Verde (MT)	Forest Margins Farms Sinop (MT)	Smallholdings Jaurú Valley (MT)	Ranches Araguaína (TO)
Economies of scale	83%	-	-	30%
Increase farm land	43%	33%	60%	-
Land for children	39%	-	53%	-
New activities	22%	-	-	-
Better soil quality	9%	33%	-	70%
Living standard increase	-	34%	-	-

Therefore, one would expect that the result of an increasing living standard in the farm families would be an increase of demand for land instead of the fixation of the families on their land. The next related question is, what locations farm families would choose for acquiring new land.

The land acquisition process differs very widely in the different farming systems (table 5). In the occupation process, ranching systems were apparently the most privileged group of government settlement projects, even when in all farm families the main strategy was that of acquiring land by its own financial means. It is important to consider these facts when formulating a development strategy that attempts to fix the rural population on their land, since it would be expected that those farmers who bought their land by own financial means also have a higher interest in preserving the acquired resources.

Table 5: Land acquisition strategies in the past in different farming systems in the savannah of Brazil, 1997-98

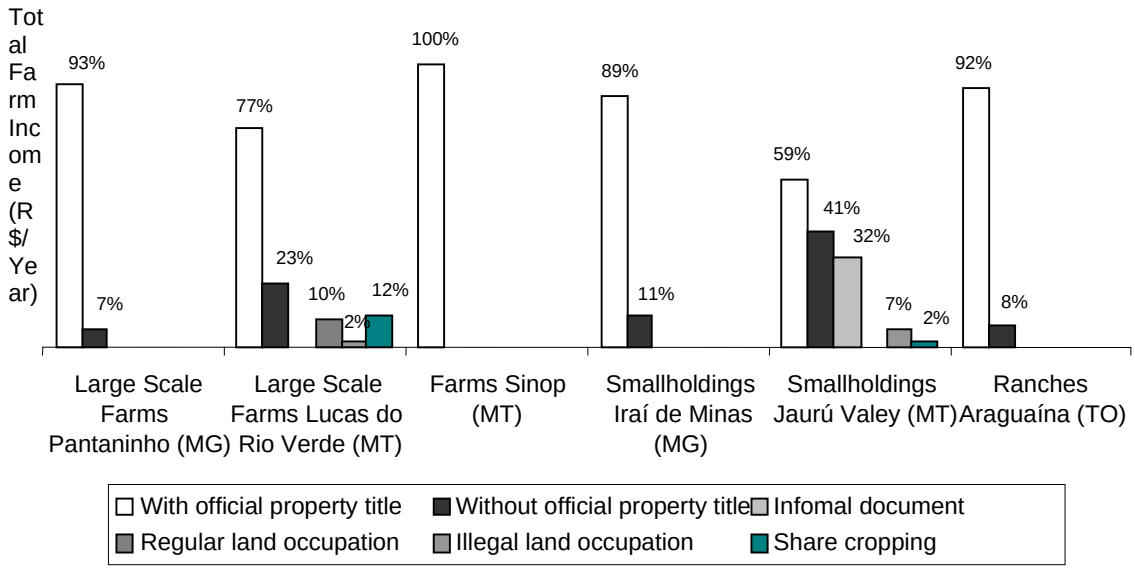
Items	Large Scale Farms Pantaninho (MG)	Large Scale Farms Lucas do Rio Verde (MT)	Forest Margins Farms Sinop (MT)	Smallholdings Iraí de Minas (MG)	Smallholdings Jaurú Valley (MT)	Ranches Araguaína (TO)
State settlement project	14%	16 %	0%	0%	15 %	41 %
Private settlement project	0%	10 %	40%	0%	0 %	0 %
Land occupation	43%	26 %	0%	0%	17 %	19 %
Private acquisition	43%	61 %	56%	38%	56 %	75 %
Heritage	0%	0 %	8%	62%	17 %	0 %

Heritage as a way of getting land was exclusively mentioned by smallholder families, which is a consequence from the traditional occupation patterns in the past as described before. The land ownership status is partly a result of the different land acquisition strategies used by the families in the different systems. The relatively high number of indications of the strategy “land occupation” may also be an indicator for the potential of possible social unrest in the region.

While in private or governmental settlement projects and in private land acquisitions farmers got an official land ownership title, this was not always the case when the land was occupied

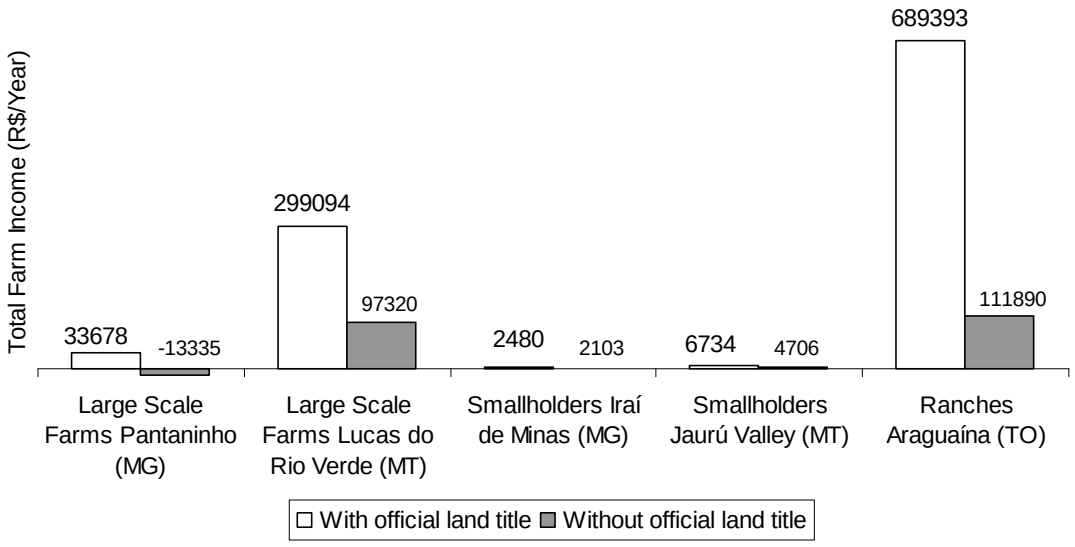
regularly or illegally, acquired informally or through heritage or is used with share cropping (figure 1).

Figure 1: Types of land ownership in different farming systems in the savannah of Brazil, 1997-98



The consequence of such land ownership patterns may have an impact on the farm income of the farm families as shown in figure 2. Nevertheless, since standard deviations are quite high the conclusions drawn can be considered as trends only.

Figure 2: Farm income clustered according to farms with and without formal land ownership title in the savannah of Brazil, 1997-98



The land ownership status again helps to explain why for example ranchers and large scale crop farmers had better access to external capital resources for the acquisition of land than smallholders, which, like large scale farm families, relied more on capital generated outside the farm (table 6).

Table 6: Means of land acquisition in different farming systems in the savannah of Brazil, 1997-98

Items	Large Scale Farms Lucas do Rio Verde (MT)	Smallholdings Jaurú Valley (MT)	Ranches Araguaína (TO)
With capital generated from off-farm	61 %	49 %	91 %
With capital generated from on-farm	45 %	51 %	13 %
With capital from credits	16 %	15 %	41 %

This fact is important, because the main instrument used by the Brazilian Government to modernise the country's agriculture was rural credits at highly subsidised rates of interest, though less than one third of producers had access to this benefit (Goodman and Redclift, 1991). The credit mainly benefited big and medium farmers (table 7). Especially large scale mechanised farmers coming from the south depend very much on external capital, while smallholders and ranchers use much less credit money. In fact, the requirement of land ownership for the concession of rural credits has been an additional factor in removing smallholdings from agricultural production (MAA, 1998).

Table 7: Credit use in different farming systems in the savannah of Brazil, 1997-98

Items	Large Scale Farms Pantaninho (MG) (n=29)	Large Scale Farms Lucas do Rio Verde (MT) (n=28)	Forest Margin Farms Sinop (MT) (n=25)	Smallholding Iraí de Minas (MG) (n=35)	Smallholding Jaurú Valley (MT) (n=41)	Ranches Araguaína (TO) (n=32)
Farms using credit	90%	89%	64%	9%	54%	22%
Total credit per farm (R$)	57,592 (74,043)	1,096,556 (3,201,554)	172,931 (280,970)	-*	15,252 (14,727)	186,781 (36,689)
Total credit per land (R$/ha)	129 (69)	506 (537)	260 (305)	-*	296 (204)	175 (133)

Figures in parentheses: standard deviations. n: the number of samples * no data available

As credit concessions also depended on the size of cultivated land, many farmers ploughed areas of land larger than they were really prepared and allowed to cultivate. An indication of this is that the law requirement, that obliges the farmers in the savannah, including smallholders and large scale farmers, to keep as natural vegetation reserves 20% of their land and those in the forest and forest margins, including ranchers, 50% of their properties, is not being completed by almost all farmers in the region. Actually, the large scale cropping farmers in Minas Gerais and Mato Grosso have similar percentage of native land of 14% and 12%, respectively. The ranchers and the farms in the forest margins have 33% and 46% of their land preserved as native vegetation. The low levels of native vegetation in smallholders farming systems in Minas Gerais (5%), as well as in Mato Grosso (6%), may be a result of the relatively small farm sizes, which urge farm families to cultivate up to the maximum their farm land to sustain their living standard.

Future land scarcity

The ongoing occupation process and the deterioration of land due to unsustainable practices have led to an increasing awareness of farmers about the increasing scarcity of land in the savannah region (table 8). The land availability situation at present is not satisfactory according to the opinion of most farmers.

Table 8: Minimum cropping land required and the corresponding surplus or deficit in different farming systems in the savannah of Brazil, 1997-98

Items	Large Scale Farms Lucas do Rio Verde (MT) (n=28)	Forest Margin Farms Sinop (MT) (n=25)	Smallholdings Jaurú Valley (MT) (n=41)	Ranches Araguaína (TO) (n=32)
Minimum cropping land needed (ha)	370 (250)	760 (912)	45 (36)	788 (628)
Families with deficit	26%	33%	37%	19%
Deficit (% of total land)	18%	23%	74%	21%

Figures in parentheses: standard deviation. n: the number of samples

The deficit of land felt by many farm families could be a reason for them to move into unexplored land, repeating the experience from the past (see table 1). This is especially true, when looking at the economic implications for the farm family related to the land availability (table 9). While the land availability variables and some criteria of the economic success of the family are positively correlated at a high significance level in ranches and in large scale farms, this is not the case in smallholdings. This is due to the fact that the production systems of ranchers and large scale farms are more homogeneous (soybean, maize and cattle), while smallholding systems are much more diversified, ranging from a high level of intensification in vegetable and fruit production for the market up to production systems for subsistence only. Different correlation levels also result from the high standard deviation of the farm land in the case of ranchers and large scale farms compared to the relatively small standard deviation in smallholding systems.

Table 9: Relation of land availability and economic success in different farming systems in the savannah of Brazil, 1997-98

Items	Large Scale Farms Lucas do Rio Verde (MT)		Smallholdings Jaurú Valley (MT)		Ranchers Araguaína (TO)	
	Correlation coefficient	Significance level	Correlation coefficient	Significance level	Correlation coefficient	Significance level
Crop income	0.28	*	-0.08	-	0.03	*
Livestock income	0.94	***	0.18	-	0.48	***
Farm income	0.70	***	0.05	-	0.46	***
Family income	0.70	***	0.14	-	0.47	***
Cash income	0.28	*	-0.10	-	0.39	**

* Significance : p = 90% - level ** Significance : p = 95% - level *** Significance : p = 99% - level

Strategies to overcome future land scarcities

From the analysis of the reasons for future land acquisitions the hypothesis was stated, that smallholders and large scale farmers mainly face problems with the quantitative scarcity of land, while ranchers and forest margins farmers mainly have problems with the qualitative scarcity of land. Independently of this, the majority of the farmers, expressed their interest to acquire more land in the future (table 10). Only in the case of the ranchers and the farmers at the forest margins this does not hold true, most probably because the farms in these areas are subject to a strict law that urges them to keep a minimum of 50% of their land property in its natural conditions.

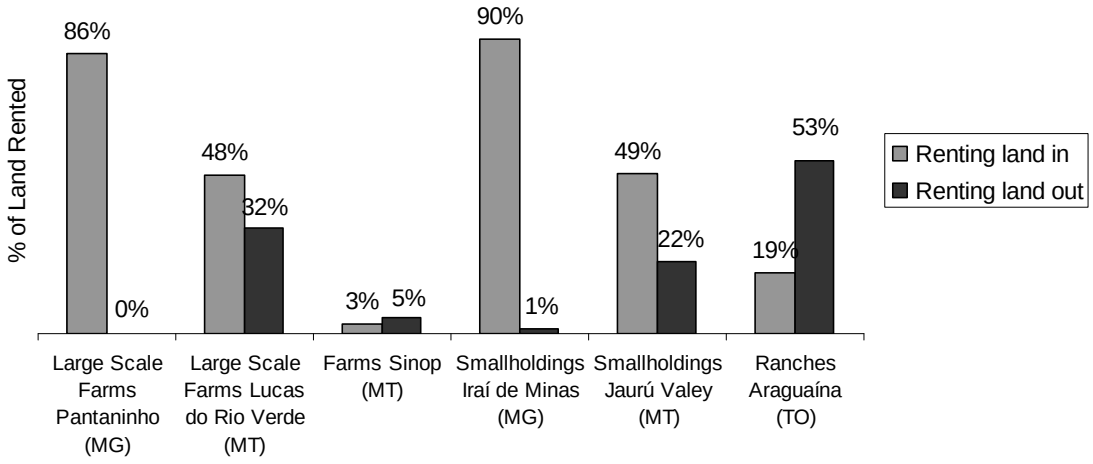
Table 10: Land acquisition strategies in the future in different farming systems in the savannah of Brazil, 1997-1998

Items	Large Scale Farms Lucas do Rio Verde (MT) (n=28)	Forest Margin Farms Sinop (MT) (n=25)	Smallholdings Jaurú Valley (MT) (n=41)	Ranches Araguaína (TO) (n=32)
Yes	74%	17%	73%	31%
No	26%	70%	27%	69%
Does not know	-	13%	-	-
Neighbours	26%	-	39%	36%
State settlement areas	61%	-	23%	0%
Agricultural frontier	57%	-	0%	45%
Urban areas	43%	-	22%	27%

Facing this situation of increasing land scarcity in the savannah region farmers were asked about the locations where they intended to obtain land in future. The results summarised in table 10 show that large scale farmers and ranchers are both heading towards land acquisition in new agricultural frontier areas. The fact that large scale farmers also show a high interest for land in government settlement areas is related to some new settlement projects recently started nearby the study area. Due to logistic reasons most farmers prefer to acquire land in the neighbourhood.

A second, but only short-term alternative for solving the land scarcity problem is renting land, as presented in figure 3. At present this activity is more intensively being used by large scale farmers and smallholders in Minas Gerais. A possible explanation for this could be, that these areas were occupied before and therefore have a more developed land market.

Figure 3: Renting of land in different farming systems in the savannah of Brazil, 1997-98



Nevertheless, the possibility of renting land does not offer a long-term solution for the land scarcity problem. The issue of land scarcity is closely related to the land degradation problem. Few question the success of modern agriculture packages in increasing agricultural production and productivity in a short-term perspective, but there is a wide consensus about their adverse social and environmental effects (Mueller et al., 1992). Some of these effects, like the losses of soil fertility are clearly perceived by the farmers themselves. While 75% of the ranchers and 73% of the smallholders declared to have problems with decreasing soil

fertility, only 16% of the large scale cropping farmers answered the same. The reason for this is likely

to be, that some technologies were adapted to counteract some of the negative effects of the land occupation (Table 11). These technologies are particularly well suited to farmers with large farms and, consequently, access to rural credits.

Table 11: Land conservation measures used in different farming systems in the Savannah of Brazil, 1997-98

Items	Large Scale Farms	Smallholdings	Ranches
Level curves	91%	0%	6%
Land reclamation projects	61%	0%	0%
Reforestation	22%	0%	0%
Crop – pasture rotation	91%	0%	16%
Drained streets	78%	0%	0%
No-tillage technology	70%	0%	0%
No conservation measures	0%	100%	38%

What is more, their implementation requires a degree of education beyond that of the average small producer (Table 12). Most farmers who take part in the agriculture modernisation in the savannah come from outside the region and have already some education and training in using modern technologies, while the local population with a lower education level is excluded from this process.

Table 12: Education level of the families head in different farming systems in the savannah of Brazil, 1997-98

Items	Large Scale Farms Pantaninho (MG)	Large Scale Farms Lucas do Rio Verde (MT)	Smallholdings Iraí de Minas (MG)	Smallholdings Jaurú Valley (MT)	Ranches Araguaína (TO)
Not formal	5%	-	49%	46 %	6 %
Primary	86%	74 %	51%	46 %	47 %
Secondary	9%	13 %	-	7 %	31 %
Higher	-	3 %	-	-	16 %

Therefore, the technologies developed are strongly biased toward medium and large, capital-intensive producers and cash crops (especially soybeans, wheat, maize and rice). Because of this, even if most farmers in all three systems identified soil fertility losses on their farm land, none of the smallholders and a high percentage of ranchers do not use any soil conservation methods at all (Table 11), while the highly modernised and market-oriented large scale farming systems, the farmers are more active in preventing and solving the negative environmental consequences of their farming practices than in the other systems. It may be expected that producers who live on their farms would be more concerned about the state of the place where they have their home. Finally, it is remarkable, that more than half of smallholders and more than one third of large scale farmers as well as nearly one fourth of the ranchers consider that an additional expansion of their land would not be of any benefit for them. This information goes in line with the intention of several farmers to sell parts or all their land (large scale farmers: 19%; forest margins farms: 6%; smallholders: 0% ; ranchers: 53%). This would imply finding other income sources, mainly in off-farm activities, which is a strategy with a high potential for solving the land scarcity difficulties of the farm families and improving their living standard at the same time. At the present situation the off-farm income plays an important role in the family income composition, especially in smallholder farming systems in Minas Gerais and Mato Grosso, were 37% and 49% of the family income, respectively, is generated in off-farm activities. They are followed by ranchers (18%), forest margins farms (12%) and large scale cropping farming systems in Mato Grosso (4%) and Minas Gerais (1%).

Conclusion

The study presents some key factors for research in the reorganisation process of social, environmental, technological and land management in the savannah of Brazil. The analysis show, that a differentiated treatment of farming systems is needed, due to the different agro-ecological characteristics of farming systems in the region. The unequal distribution of land is seen as a major impediment for the sustainable development of the farming systems. The long term motivation of farm families to use their land resources in a sustainable way seems to be influenced by the future income expectations and push factors for land occupation. These relationships still need further research, because of their impact on land acquisition strategies, in order to reduce the pressure on the unexplored land. Further, the study revealed that an increasing living standard does not necessarily lead to the fixation of the farm families on their land. In some situations an increasing living standard may even increase the demand for unexplored land. Therefore, the understanding of the driving forces behind the land use decision making process needs further studying to determine in what situation and under what conditions an impact of a certain type could be expected. The analyses of some driving forces, like the land ownership status, the distribution of the land resources, education and credits, showed that these may cause social conflicts, increase land scarcity problems and the degradation of land resources, as well as the pressure on unexplored land. Therefore, sciences could also give valuable support in finding new strategies to overcome future land scarcity problems. The strategies of acquiring unexplored land or renting land are either undesirable from an environmental point-of-view or they offer a short-time solution only. The greatest development potentials for the farming systems are expected in the adoption of land conservation technologies and the development of off-farm income opportunities. These key factors will be of increasing importance to contribute in solving the land scarcity problematics and to reduce the pressure on the remaining areas.

References

Doppler W. (1994): Farming Systems And Rural Development - Concepts And Methods. Wissenschaftsverlag Vauk, Kiel, Germany.

Doppler W. (1997): Landwirtschaftliche Betriebssysteme in den Tropen und Subtropen, Eugen Ulmer GmbH & Co., Germany.

Dörner J. (1999): Wirtschaftspotentiale und Wettbewerb zwischen Forstwirtschaft und Landwirtschaft in einem Waldgrenzgebiet in Nord Mato Grosso, Brasilien. M.Sc. Thesis, University Hohenheim, Germany.

Goodman D. and Redclift M. (1991): Refashioning Nature, Routledge, London and New York.

Grundmann P. (1999): Potential and Strategies for Sustainable Development of Farming and Regional Systems in the Brazilian Savannah (manuskript, Universität Hohenheim).

MAA (1998): Regras para safra. Ministério da Agricultura e do Abastecimento. Brasília, DF.

Mueller C.C., et al. (1992): An Analysis Of Forest Margins And Savanna Agrosystems In Brazil. Brasília: Instituto Sociedade, Populaçao e Natureza.

Mueller C.C. (1995): A Sustentabilidade da Expansao Agrícola nos Cerrados. Documento de Trabalho N° 36. Brasília: Instituto Sociedade, Populaçao e Natureza.

Santacoloma P. (1999): Strategies For An Economically And Ecologically Balanced Development In Small Region In The Brazilian Savannah (manuscript, Universität Hohenheim).