Journal of Agriculture in the Tropics and Subtropics
Volume 103, No. 1, 2002, pp. 47 - 59

The Land Resource Information and Suitability System for Family Agriculture (LARISSA), developed for the Brazilian agrarian reform

G. Sparovek [1*], M. Cooper [1], D. Dourado-Neto [1], R.F. Maule [2], P. Vidal-Torrado [1], L.F. de M. Pimenta [3], S.P. Martins [3], E.R. Teramoto [1], A.C. Silva [4], J. Van de Steeg [5], E. Schnug [5]

Keywords: Land evaluation, agrarian reform, family agriculture, Brazil

Abstract

Family Agriculture (FA), supported by the Brazilian government and society, is recognized as essential for rural life-quality improvement and for the maintenance of natural resources. FA competes for the same natural and regional resources as commercial agricultural production. Without support the commercial production would tend to withdraw FA from the most suited regions. FA has important differences when compared to commercial agriculture. The consumption-driven propose of FA rather than the market-orientation of commercial agriculture influences the factors that may improve or constrain production. In FA high yields are usually substituted by crop quality standards and monocultural systems by diversified production. The macroeconomic scenario that drives the markets for most commercial crops plays a minor role in FA. The maintenance of natural resources, integrating the forest with the agricultural ecosystems, and the reduction in the use of pesticides and fertilizers are other features that usually distinguish FA. Land evaluation procedures targeting the promotion of FA should consider its specificity. The currently adopted methods used to support Brazilian governmental programs are based on tools developed for commercial agriculture. These methods are not sufficiently sensitive to farmers' traditional knowledge, crop quality and diversity importance, consumption-driven character and local markets, which are important factors in FA production. The non-consideration of these issues during the planning stage is frequently impairing FA's development. LARISSA is an expert system composed of a computer program, field procedure

[1] University of São Paulo, CP 9, 13418-900, Piracicaba (SP), Brazil
[2] FAO/INCRA, SBN-Edifício Palácio do Desenvolvimento, 70057-900, Brasília (DF), Brazil
[3] Ministry of Agrarian Development, Esplanada dos Ministérios, Bloco A, 70043-900, Brasília (DF), Brazil
[4] University of Alfenas, CP 23, 37130-000, Alfenas (MG), Brazil
[5] Federal Agricultural Research Center (FAL), Bundesallee, 50. D-38116, Braunschweig, Germany
* Corresponding Author

guidelines and training course designed for land evaluation for the Brazilian FA production. LARISSA may improve the efficiency of the governmental programs, help driving decisions and guide research for FA development. By developing FA, rural poverty is decreased and life-quality improved by a production system that is more labor intensive and environmentally friendly.

1 Introduction

Land evaluation may be defined as the process of assessment of land performance when used for a specified purpose, or as the methods employed to explain or predict the use potential of land (ROSSITER, 1996). The former land capability classification (KLINGEBIEL and MONTGOMERY, 1961) was followed by the Food and Agriculture Organization of the United Nations (FAO) "Framework for Land Evaluation" (FAO, 1976) and recently by a more quantitative approach, including social and economic variables in prediction models (VAN DIEPEN *et al.*, 1991). The current trend is to quantitatively focus on alternative options from which the stakeholders can choose, rather than on single clearcut solutions (BOUMA, 1997); include sustainability indicators as part of the evaluation procedures (HURNI, 2000) and increase the adoption of information technologies.

The Brazilian society has recognized the importance of access to land for poor rural landless families and the direct support of FA as efficient towards promoting income equality distribution and improving rural life-quality. This recognition is expressed by actions of organized social movements e.g. Landless Rural Workers Movement (MST). Also government's direct investments e.g. the National Institute for Colonization and Agrarian Reform (INCRA) with an annual budget equivalent to 1.2×10^9 US$ for Agrarian Reform (AR) settling 75×10^3 families per year on 9×10^6 ha of unproductive land (GASQUES and VERDE, 1998; INCRA, 2000) and the National Program for Strengthening of Family Agriculture (PRONAF) designating propitious credits (2.0×10^9 US$ y^{-1}) for FA (INCRA, 2000); are significant indicators of FA supports.

In FA inputs such as chemical fertilizers, pesticides, genetically improved material are usually substituted by labor or cultural values (e.g. manual weed control), biodiversity (e.g. multicultural systems instead of monoculture reducing the need of pesticides) and genetic material focusing on crop quality (e.g. taste and healthiness instead of productivity). FA is also more friendly to the maintenance of the forests. In commercial farming, the forest is usually considered as a non-productive resource that will have a market value only if converted to timber. The preservation of the forest in commercial farming has shown to be effective only with legal support and surveillance (LAURANCE *et al.*, 2001). In the Brazilian Agrarian Census 1995/6 data, GUANZIROLI and CARDIM (2000) identified 4,139,369 FA farms. These represented 85 % of the total number of farms occupying 30 % of the Brazilian farming area. FA was also responsible for 38 % of the agrarian net production and received 25 % of the credits. From the total Brazilian rural population of 34 million people in 1996, 14 million (41 %) were occupied with FA.

The Brazilian Federal Constitution defines that property has social functions. This principle applied to the agrarian sector attributes the Union to expropriate, for social benefit, land that does not fulfill its social functions. Excluded from expropriation are all small farms and large farms that are productive. A large farm may be considered as unproductive (i.e. not in accordance to its social functions) based on the identification of inadequate land use. In this case, the National Institute for Colonization and Agrarian Reform (INCRA) may acquire the area and divide it in small units of 25-100 ha that are refinanced under attractive conditions to landless families. The main issue of the AR process, and probably one of its weakest points, is the prediction of the future performance of FA. If FA fails to improve, the AR purpose for giving social functions to land will not be achieved. This prediction is currently regulated by a law described in the Normative Instruction 31 (INCRA/DF, 1999). This instruction is based on land capability classification (LCC) concepts (Klingebiel and Montgomery, 1961), one of the first modern land evaluation tools developed by the United States Department of Agriculture (USDA) to support decisions on soil conservation in the 60s and 70s. LCC considers only commercial high-input agriculture and is entirely physically based. The land capability classification is attractive due to its simplified class structure. The most suited land for annual crops is represented by class " I " following down to the land unsuited for agriculture on class " VIII ". The advantage of being easy to understand makes LCC attractive for lawyers, court judges and bureaucrats who play a major role in the AR process. Although this advantage is widely surpassed in importance by inherent disadvantages. The most important is the non-consideration of FA specificity, it is conceptually designed for commercial high-input agriculture and emphasizes only on soil and landscape attributes, ignoring social, cultural and economic variables. The importance of the planning stage in detecting constrains for the implementation of agricultural land use is discussed by SMITH and MCDONALD (1998) and is considered as one of the main problems that explains the unsuccessfulness in improving the Brazilian AR (GUANZIROLI, *et al.*, 1999)

This paper describes the **L**and **R**esource **I**nformation and **S**uitability **S**ystem for Family **A**griculture (LARISSA) that is an expert system developed to support land evaluation decisions for the AR in substitution to the currently used methods.

2 LARISSA's general description

Most data used to develop LARISSA were obtained during field work. From August, 1999 until July, 2000 part of the authors made 60 one-week field trips visiting 150 settlement projects covering the whole Brazilian territory. Soil and landscape relations to land use types and development patterns were observed. Farmers, extensionists, regional politicians, and researchers were interviewed. The reports resulting from theses surveys were complemented by data collected in other localities. A second visit had the objective to revise and discuss the initial report.

Land evaluation for AR has to be operational in a wide range of conditions. Large remote regions covered by forests with access only by boat in the Amazon, extreme semi-arid climatic conditions in the northeastern part of Brazil and the industrialized subtropics represented by the southern Brazilian areas are some examples of this range. Flexibility in relation to input data was a major concern during LARISSA's development. The modules related to soil and landscape variables were designed to operate with expeditious field surveys as described by BECKET & BIE (1978) for Land-System. The Land-System procedures suggest that the landscape should be divided according to topography, land use types or forest physiognomies using remote sense tools. For each

mapping unit, the soils are described and sampled for analytical determinations. This cartographic and sampling procedure is suggested to a) preserve the "feeling-for-land" that the evaluators have acquired during their professional life; b) allow expeditious and low cost mapping to avoid the conflict between comprehensiveness and availability identified as a main problem for land evaluation by PIERI (1997); c) complement cartographic mapping units with recent soil analytical data, pointed out by OBERTHÜR *et al.* (1996) as one of the most limiting factors of soil maps to support land use planning; and d) allow the filed procedures adoption with minimal training.
The regional conditions (RC) are pertinent to surrounding factors not related to land qualities (LQ). LARISSA was also designed to operate these variables in a flexible form. LARISSA is a modular computer program. Two modules will receive data, one related to the Supply of Land Qualities (SLQ) and the other concerning the Supply of Regional Conditions (SRC). The list of input data for SLQ is shown in Table 1.
Internal decision rules (e.g. SLQ Current Nutrient Availability shown in Table 2) or simplified models (e.g. climatic data based on water balance calculations) convert the SLQ and SRC input data into 9 LQ and 14 RC indicators as shown in Table 3.
The supplies from each indicator are rated in five restriction levels: i) not restricted (nr), ii) little restricted (lr), iii) moderately restricted (mr), iv) restricted (r), and v) very restricted (vr).
The two input modules communicate with a database module that has information about land use (LU). Each LU is recommended for a specific region and was observed to be successful in FA during the field work for LARISSA's development. In this module, for each LU the minimum demands of LQ and RC (DLQ or DRC) are defined. Also, economic and productivity variables are part of this database (e.g. maximum and minimum productivity, gross margin, spare capacity). This module was designed to be updated, considering that new land use options may arise and cost factors may change.
After providing the data for the SLQ and SRC modules the land evaluator may choose between different LUs available for the region the project is located. For each choice an analytical module will evaluate the compatibility of supplies and demands on a quantitative base using a note system, provide economical and technical parameters related to risk factors, define the minimum size of a farm to allow a target income and the maximum price for acquiring the land for AR purpose.

Table 1: Variables used in LARISSA to calculate Supply of Land Qualities (SLQ).

Soil analysis	Soil morphology	Slope
0-20 and 50-70 cm depth	0-20 and 50-70 cm depth	
cation exchange capacity, base saturation, aluminum saturation, sodium saturation, electric conductivity, organic matter, clay content, silt content	depth, stoniness, drainage, presence of stubs	steepness

Table 2: Decision rule for the definition of the supply of Current Nutrient Availability

Soil Base Saturation (0-20 cm) %	CEC [1] (0-20 cm) $mmol_c\ dm^{-3}$	SOM [2] (0-20 cm) $g\ kg^{-1}$	Restriction [3]
>75	>50	>30	nr
>75	>50	10-30	nr
>75	>50	<10	lr
>75	0-50	>30	nr
>75	0-50	10-30	nr
>75	0-50	<10	lr
51-75	>50	>30	nr
51-75	>50	10-30	nr
51-75	>50	<10	lr
51-75	0-50	>30	lr
51-75	0-50	10-30	lr
51-75	0-50	<10	mr
30-50	>50	>30	mr
30-50	>50	10-30	r
30-50	>50	<10	vr
30-50	0-50	>30	r
30-50	0-50	10-30	r
30-50	0-50	<10	vr
<30	>50	>30	vr
<30	>50	10-30	vr
<30	>50	<10	vr
<30	0-50	>30	r
<30	0-50	10-30	r
<30	0-50	<10	vr

1 CEC = soil cation exchange capacity

2 SOM = soil organic matter content

3 Restriction level: not restricted = nr; little restricted = lr; moderately restricted = mr; restricted = r; and very restricted = vr.

3 LARISSA's detailed description

3.1 The Supply of Land Quality (SLQ) module

From the 9 LQs, 6 were selected because of its importance for low-input agriculture. These LQs are current nutrient availability, capacity of maintaining nutrient availability, nutrient retention capacity, rooting conditions, soil water holding capacity, and climate. Longer lists of LQs as suggested for dryland agriculture (FAO, 1983), irrigated agriculture (FAO, 1985) or for land evaluation in Zambia (CHINENE, 1991) are justified when no specific production system is addressed and agriculture is considered comprehensively. In the case of FA production is based usually on low-input systems (ROMEIRO, 1998; SHIKI, 1998; GUANZIROLI *et al.*, 1999; BITTENCOURT and BIANCHINI, 2000; GARCIA, 2000). The lower amount of credits (GUANZIROLI and CARDIM, 2000) is only partially responsible for that. Probably, the fact that the production is strongly consumption-driven accounts for a major role for this specificity. The farmers' family will consume most of their production and therefore not only quantity but quality will be a target. Quality has a strong cultural influence and pesticides and chemical fertilizers usually do not match with its requirements. The FA farmers try to adapt to the natural resources (soil fertility, climate) rather than change them. Cycling of organic residues or organic fertilizers are used instead of chemical sources of nutrients. These are reasons for the importance of LQs related to the natural production capacity of the land in the case of FA.

Table 3: Land Qualities (LQ) and Regional Conditions (RC) considered in LARISSA.

LQ	RC
Current Nutrient Availability	Cooperative Work
Capacity of Maintaining Nutrient Availability	Farmers Background
Nutrient Retention Capacity	Neighborhood
Rooting Condition	Surroundings
Soil Water Holding Capacity	Accessibility Form
Soil Drainage	Accessibility Distance
Erosion Risk	Water Quality
Mechanization Capacity	Market
Climate	Initial Investment
	Loan
	Processing
	Technical Assistance
	Electricity Supply
	Irrigation

The other LQs were soil drainage, erosion risk and mechanization capacity. Soil drainage is difficult to amend, so it will permanently influence crop production. In most cases deficiency in drainage is a limiting factor, but in others (e.g. flooded rice) it may be essential. The erosion risk, evaluated by soil texture, depth and slope identify soil's overexploration and degradation potentials. Mechanization is defined according to animal and mechanical traction. The mechanical traction may not be important at the beginning of the development of a FA settlement project but, the farmers are inclined to substitute field operations done manually by machines. Mechanization may be used as an indicator of development potential.

3.2 The Supply of Regional Conditions (SRC) module

The RCs shown in Table 3 are mostly described by definitions as shown in Table 4 for farmers background and neighborhood. The exceptions are accessibility form, accessibility distance, electricity supply where quantitative threshold values define the restriction level. The RCs definitions should also be linked to a quantitative decision criteria. But in this case, the sources of information and the condition each region will have to reach these definitions will be extremely variable. Detailed economic analysis

Table 4: Concepts for the definition of restrictions for the Supply of Regional Condition (SRC) Farmers Background and SRC- Neighborhood used in LARISSA.

SRC-Farmers Background	**Restriction [1]**
The farmers are familiar with the proposed land use. They developed the same activity in the same region as lessors or independent producers. The farmers are familiar with the production technology and the local commercial chains.	nr
The farmers are familiar with the proposed land use. They developed the same activity in another region as lessors or independent producers. The farmers will have to adapt to local production and commercial conditions.	lr
The farmers are familiar with the proposed land use. They developed the same activity as employees and are familiar only with production technology. They are not familiar with planning the activity and with commercial aspects.	mr
The farmers know similar agricultural systems but never developed the specific land use.	r
The proposed land use is completely unknown for the farmers.	vr

SRC-Neighborhood	
The neighborhood of the Settlement Project (SP) is composed of other SPs that have improved and developed. Cooperative work with the neighbors is expected.	nr
The neighborhood is composed of other recently created SPs that may work in a cooperative and connected way.	lr
The neighborhood is not composed of other SPs, but small farms based operating on family agriculture exist regionally. No hostilities in relation to Agrarian Reform (AR) are expected and the a cooperative and connected work between neighbors is feasible.	mr
The neighborhood of the SP is composed of commercial farms. No hostilities in relation to AR are expected. There is little possibility of integrated and cooperative work with the neighbors.	r
The neighborhood of the SP is composed of large commercial farms. Hostilities in relation to AR are foreseen. There is no possibility of integrated and cooperative work with the neighbors.	vr

1 Restriction level: not restricted = nr; little restricted = lr; moderately restricted = mr; restricted = r; and very restricted = vr.

and social surveys will support the decisions in some cases and in other remote regions the opinion of the land evaluator will define the majority of the variables.

The RCs can be grouped according to their objectives. Cooperative work and farmers background are essential for more specialized crop production. In the Brazilian AR frequently the landless families are settled in regions far from their origins, so the lack of knowledge about the new environment and crop management may be a restrictive factor (BRUNO and MEDEIROS, 1998). These variables are less important for extensive systems (e.g. beef cattle production) when compared to cash crops or market-oriented production. The same reasons were pointed out as important issues in other AR conditions (WEGREN, 1994).

The variables market, neighborhood, surroundings, accessibility form and accessibility distance will give the dimension of the difficulty for implementing FA regionally and its potential for development. If the neighborhood and surroundings of the settlement project are composed predominantly of other FA farms and no hostilities to AR are expected, an integration or collaborative work may improve the new area rapidly. Access and markets are essential for long term improvement of the FA and without that the area will not surpass the subsistence level. Difficult access and an hostile surrounding were also identified as important factors toward evasions of settlement projects in Brazil by BRUNO and MEDEIROS (1998), frequently appointed in interviews during LARISSA's development and were also observed in other regions (IOFFE and NEFEDOVA, 2000).

Electricity was considered by FA farmers as important for life-quality. The access to television, power tools and household electric equipment was frequently pointed as the major difference of rural and urban life. The availability of water may also be a restrictive factor for human and animal consumption specially in semi-arid regions.

Initial investment capacity and availability of loans are essential for the development of market-oriented production. In its absence, the settlements have shown to hibernate for a long time in a subsistence level. This was identified as a major cause for evasions in settlement projects by BRUNO and MEDEIROS (1998).

The possibility of crop processing, technical assistance and irrigation are essential for more specialized products (e.g. horticulture, market-oriented fruits). The large availability of labor in a settlement project makes it more competitive as commercial systems in labor intensive processes. These products depend on processing the raw yield, which usually requires special facilities and constant technical assistance.

3.3 The Land Use Module (LU)

The LU module represents the dynamic module of LARISSA. The LUs are, conceptually, production systems based on FA that are suitable for a certain region. The suitability criteria consider the adaptation to climatic conditions, the existence of commercial chains that demand the products and the acceptance of the products for the consumption by the families. The identification of the LUs is based on well succeeded FA experiences. The selection of the LUs was made during the field work for LARISSA's development and following descriptions of FA in several Brazilian regions (ROMEIRO, 1998; SHIKI, 1998; GUANZIROLI *et al.*, 1999; BITTENCOURT and BIANCHINI, 2000; GARCIA, 2000). The LU module generates demands for LQ and RC named Demand for Land Quality (DLQ) and Demand for Regional Conditions (DRC). This module was designed to allow constant update, revision and enlargement.

3.4 The Analytical module

In this module, the qualitative levels of supplies and demands are first converted in quantitative variables. A linear increase, with 1 representing the most restricted condition (very restricted or vr) up to 5 for the less restricted condition (not restricted or nr) is used for this conversion. A percentage value is then calculated. The value of 100% will represent a condition in which all supplies are equal to the maximum value of 5, and a percentage of 0 % a condition in which all supplies are equal to 1. The suggested LU will demand LQ and RC the same way. These percentages are integrative indicators, useful to position the settlement project in relation to the intensity of LU and suitability for FA. A low percentage value for SLQ or SRC will indicate low suitability for FA therefore, compatible only with LUs with low demands. The deviation between the supplies and demands are also presented as percentage positive or negative values. A negative deviation will indicate that the demands surpass the supplies resulting in a unsuited development condition. A positive deviation will indicate that the supplies surpasses the demands of the LU resulting in a suited development condition. This may also indicate a condition with the possibility of improvement or intensification of the selected LU. A deviation close or equal to zero will indicate a suited condition but with low possibility of improvement. The suitability, by comparing the supplies and demands of LQ and RC is the first step of an evaluation procedure. The suited LU types are also analyzed for their economic feasibility.

For economic feasibility, the variables defined in the LU module are converted into indicators (Table 5). The feasibility criteria are based on the expected minimum income per family and the family's spare capacity. The spare capacity will indicate a maximum amount of income to honor the debt payment and the maximum value to acquire the area, if AR is considered. Two conditions are required for a SP to be considered economically feasible. The first condition is that the annual family spare capacity must be equal or higher than the value of the annual debt payment for the land. The payment of the land should not interfere with the families income needed for production and subsistence, therefore it's based on spare capacity and not on total income. The second condition is that the expected minimum monthly income per family must be higher than the minimum regionally defined income. Once the economic feasibility criteria are attained, LARISSA calculates the ideal number of families to be settled and the size of the lot each of them will receive.

The definition of the maximum expropriation value is an important feature of LARISSA for the AR process. The value of agricultural land, when analyzed on a theoretical basis (OLARIETA, 2000) is certainly a controversial issue. But for practical reasons, LARISSA had to incorporate a quantitative land value. The currently used methods define the value of land as a function of land capability classes and recent sale values surveyed locally. The restrictions of this procedure are a weak relation of land capability and land value (DAVIDSON, 1989) and absence of guarantee that the FA system will provide enough income to allow the farmer honor his mortgage under current market prices. Margin values as used by LARISSA, which are based on cash in- and out-flow calculations, are considered as simple, but valid methods for economic land evaluation (ROSSITER, 1996).

Table 5: Economic variables defined in the Land Use module (upper part) and the indicators calculated by LARISSA's analytical module (lower part).

Variable	Description	Unit	Suggested Value
AR	Net area of the settlement project	ha	
VD	Expropriation value	R$ *	
NS	Number of settlement persons		
Tp	Time for paying the area	year	20
Pm	Market Price of the products from LU	R$/production unit	
P	Productivity of the LU	Production unit/year	
Lo	Loan cost for production of the LU	R$/ha year	
S	Service costs for production of the LU	R$/ha year	
I	Interest cost for production of the LU	R$/ha year	
Sc	Spare capacity of the net margin	rate (0-1)	0.3
Tip	Time to start paying the area	year	3
NImin	Minimum net income for each settled	R$/ month	

Indicator	Description	Unit	Formula
ArS	Area for each settled	ha	AR/NS
TVS	Total value for each settled	R$	EV/NS
AP	Annual payment for each settled	R$/year	EV/(NS*(Tp-Tip))
Np	Net profit of the LU	R$/ha year	(Pm*P)-(Lo+S+I)
Gp	Gross profit of the LU	R$/ha year	Pm*P
Co	Cash flow out of the LU	R$/ha year	Lo+S+I
Sc	Spare capacity for each settled	R$/year	(Pm*P-(Lo+S+I))*Sc*AR/NS
EV/ha	Expropriation value per hectare	R$/ha	EV/AR
EVmax	Maximum expropriation value	R$	(Pm*P-(Lo+S+I))*Sc*(Tp-Tip)*AR
EVmax/ha	Maximum expropriation value per ha	R$/ha	(Pm*P-(Lo+S+I))*Sc*(Tp-Tip)
NIexp	Expected net income for each settled	R$/month	(Pm*P-(Lo+S+I))*AR/(12*NS)

* R$ = Reais (Brazilian currency)

3.5 Outputs

The reports provided by LARISSA have a standard format and are automatically generated. The advantage of this procedure is a significant reduction in the time needed for bureaucratic office work. This is essential to compensate the field work that has been increased as compared to the currently adopted methods. Another advantage of standardized output formats is to easier understand and compare the evaluations. This is important due to the fact that the final decision on acquiring land for AR is a direct responsibility of the Minister, thus centralized on a small staff that has to analyze, compare, and decide among the 3,000 annual reports considering that only approximately 20 % of the surveyed areas are effectively used for AR.

4 Conclusions

LARISSA is a land evaluation expert system for family agriculture based production designed specifically for the Brazilian agrarian reform.

This specific design allows more precise and objective land evaluation without increasing the need or skill for human or financial resources.

LARISSA considers physically based variables (Land Qualities) and socio-economic condition (Regional Conditions) for evaluating regionally feasible land use types.

This more comprehensive and specific design as compared with the currently adopted methods, may reduce misevaluation problems.

Misevaluation problems frequently impair the development of family agriculture or result in the legal obstruction of the agrarian reform process.

5 Acknowledgements

This project was sponsored by the National Institute for Colonization and Agrarian Reform (INCRA) and coordinated by the University of São Paulo (USP).

Zusammenfassung

Das Land Ressourcen Informations- und Eignungsprüfungs- System für kleinbäuerliche Landwirtschaft (LARISSA) entwickelt für die Umsetzung der brasilianischen Agrarreform.

Kleinbäuerliche Landwirtschaft (FA für "Family Agriculture") ist notwendiger Bestandteil der Lebensqualität im ländlichen Raum und ebenso notwendig für die Erhaltung natürlicher Ressourcen und wird daher von Staat und Gesellschaft in Brasilien unterstützt. FA konkurriert mit industriell orientierter Landwirtschaft um die gleichen Ressourcen, aber hat in diesem Wettstreit ohne staatliche Unterstützung nur geringe Chancen. FA unterscheidet sich in wesentlichen Merkmalen von industrieller Landwirtschaft, was bei der Auswahl geeigneter Standorte für FA zu berücksichtigen ist. Die bisher in Brasilien benutzten Systeme zur Landbewertung sind speziell auf die Belange industrieller Landwirtschaft abgestimmt und benachteiligen dadurch die Entwicklung von FA. Insbesondere werden Faktoren wie traditionelle Kenntnisse und Methoden, Produktqualität und Diversifikation unzureichend oder nicht berücksichtigt. LARISSA (**L**and **R**esource **I**nformation and Suitability **S**ystem for Family **A**griculture) besteht aus einem rechnergestützten Expertensystem und Richtlinien und Trainingskursen für die Ansprache von Land und Standorten. Mit Hilfe von LARISSA verbessert und beschleunigt sich der administrative Evaluierungs- und Entscheidungsprozess der Land- und Standortbeurteilung, womit wiederum Armut im ländlichen Raum effizienter abgebaut werden kann.

Schlüsselwörter: Land Bewertung, Agrarreform, Kleinbäuerliche Landwirtschaft, Brasilien

6 References

BECKET P.H.T. and S.W. BIE, 1978: Use of soil and land-system maps to provide soil information in Australia. *Division of soil technical paper* No 33, CSIRO.

BITTENCOURT G.A. and V. BIANCHINI, 2000: Family agriculture in agrarian reform areas: study of production systems in Boa Ventura (PR) and Quilombo (SC) (South region). INCRA/FAO, 72 pp. (in Portuguese)

BOUMA J., 1997: The role of quantitative approaches in soil science when interacting with stakeholders. *Geoderma* 78, 1-12.

BRUNO R. and L. MEDEIROS, 1998: Percentage and causes of evasions in rural settlement projects. Project UTF/BRA/036/BRA, 54 pp. (in Portuguese). Available under http://www.INCRA.gov.br/fao/

CHINENE V.R.N., 1991: The Zambian land evaluation system (ZLES). *Soil Use and Management* 7, 21-30.

DAVIDSON D.A., 1989: The influence of land capability on rural land sales. A case-study in Renfrewshire, Scotland. *Soil Use and Management* 5, 38-44.

FAO, 1976: A framework for land evaluation. *Soils Bulletin 32*. Food and Agriculture Organization of the United Nations, Rome.

FAO, 1983: Guidelines: land evaluation for rainfed agriculture. *Soils Bulletin 52*. Food and Agriculture Organization of the United Nations, Rome.

FAO, 1985: Guidelines: land evaluation for irrigated agriculture. *Soils Bulletin 55*. Food and Agriculture Organization of the United Nations, Rome.

GARCIA D.P., 2000: Family agriculture in agrarian reform areas: study of production systems in Campos Goytacazes (RJ), Pontal do Paranapanema, Alta Araraquarense and Promissão (SP) (Southeast region). INCRA/FAO, 69 pp. (in Portuguese). Available under http://www.INCRA.gov.br/fao/

GASQUES J.G. and C.M.V. VERDE, 1998: Thirty years of Federal investments in agrarian politics. (INCRA/FAO), 60 pp. (in Portuguese). Available under http://www.INCRA.gov.br/fao/

GUANZIROLI C.E. AND S.E. DE C.S. CARDIM, 2000: The new picture of family agriculture. The rediscovered Brazil. INCRA/FAO, 74 pp. (in Portuguese). Available under http://www.INCRA.gov.br/fao/

GUANZIROLI C.E., BITTENCOURT G.A., CASTILHOS D.S.B DE, BIANCHINI V. and H.B.C DA SILVA, 1999: Main factors that influence the development of agrarian reform settlements in Brazil. INCRA/FAO, 62 pp. (in Portuguese). Available under http://www.INCRA.gov.br/fao/

GUANZIROLI C.E., FREITAS A. and P.A. DAVIES, 1999: Family agriculture in agrarian reform areas: study of production systems in the State of Maranhão (Northeast region). INCRA/FAO, 67 pp. (in Portuguese). Available under http://www.INCRA.gov.br/fao/

HURNI H., 2000: Assessing sustainable land management (SLM). *Agriculture, Ecosystems and Environment* 81, 83-92.

INCRA, 2000: Balance 1999 - Agrarian reform and family agriculture. INCRA, 50 pp. (in Portuguese)

INCRA/DF, 1999: Procedures of expropriation for social benefits. Normative Instruction No 31. (in Portuguese)

IOFFE G. and T. NEFEDOVA, 2000: Areas of crisis in Russians agriculture: A geographic perspective. *Post-Soviet Geography and Economics* 41, 288-305.

KLINGEBIEL A.A. and P.H. MONTGOMERY, 1961: Land Capability Classification. USDA. Agricultural Handbook 210. US Government Printing Office, Washington, DC.

LAURANCE W.F., COCHRANE M.A., BERGEN S., FEARNSIDE P.M., DELAMÔNICA P., BARBER C., D'ANGELO S. and T. FERNANDES, 2001: The Future of the Brazilian Amazon. *Science* 291, 438-439

OBERTHÜR T., DOBERMANN A. and H.U. NEUE, 1996: How good is a reconnaissance soil map for agronomic purposes ? *Soil Use and Management* 12, 33-43.

OLARIETA J.R., 2000: On the use value of land in agricultural production. *Ecological Economics* 32, 169-173.

PIERI C., 1997: Planning sustainable land management: the hierarchy of user needs. *ITC Journal* 3-4, 223-228.

ROMEIRO A., 1998: Family agriculture in agrarian reform areas: study of production systems in the region of São Miguel de Guamá, PA (North region). INCRA/FAO, 65 pp. (in Portuguese)

ROSSITER D.G., 1996: A theoretical framework for land evaluation. *Geoderma* 72, 165-190.

SHIKI S., 1998: Family agriculture in agrarian reform areas: study of production systems in the Savanna (Cerrado) region (Central East region). INCRA/FAO, 72 pp. (in Portuguese)

SMITH C.S. and G.T. MCDONALD, 1998: Assessing the sustainability of agriculture at the planning stage. *Journal of Environmental Management* 52, 15-37

Van Diepen C.A., Van Keulen H., Wolf J. and J.A.A. Berkhout, 1991: Land evaluation: from intuition to quantification. In: B.A. Stewart (Editor), Advances in Soil Science. Springer, New York, pp. 139-204.

WEGREN S.K., 1994: New perspective on spatial patterns of agrarian-reform. A comparison of two Russian Oblasts. *Post-Soviet Geography* 35, 455-481