Study on the Blackbird

(*Agelaius ruficapillus* Vieillot – Emberizidae, Aves)

in the rice production areas of Southern Rio Grande do Sul, Brazil

Basis for a population control management program

Júlio J. C. da Silva

Promotoren: Dr. ir. E. A. Goewie
Hoogleraar Maatschappelijke Aspecten van de Biologische Landbouw
Landbouwuniveriteit Wageningen, Nederland

Dr. M. L. Asmus
Professor and Head of the laboratory of Systems Ecology
Rio Grande University, Brazil

Júlio J. C. da Silva

Study on the Blackbird (*Agelaius ruficapillus* Vieillot – Emberizidae, Aves) in the rice production areas of Southern Rio Grande do Sul, Brazil

Basis for a population control management program

Proefschrift
ter verkrijging van de graad van doctor
op gezag van de rector magnificus,
dr. C. M. Karssen
in het openbaar te verdedigen
op 23 juni 1999
des namiddags om 16.00 uur in de aula

The studies presented in this book were performed in Southern Rio Grande do Sul, Brazil. They form part of the project 04.094.443.15 — The importance of Blackbirds on irrigated rice, under co-ordination of Silva, J. J. C. da (Researcher of the Agricultural Research Centre for the Temperate Climate Region, Brazil)

P. O. Box 403
96001-970 Pelotas, RS
Brazil

Silva, J. J. C. da
Study on the Blackbird (*Agelaius ruficapillus* Vieillot – Emberizidae, Aves) in the rice production areas of Southern Rio Grande do Sul, Brazil: Basis for a population control management program / J. J. C. da Silva. – [S.1.: s.n.].
Thesis Landbouw Universiteit Wageningen. – With ref.-
With summary in Dutch and Portuguese
ISBN 90-5808-039-0

Keywords: *Agelaius ruficapillus*, Blackbird, rice, management program, participatory approach, Rio Grande do Sul, Brazil.

Cover illustration: Rafael A. Dias

Propositions

1. Local knowledge and participation in the design and implementation of research are essential to ensure that it meets local need. Also, by involving farmers and extensionists in the whole research process, one can expect a sense of responsibility in implementing the research findings thus increasing the likelihood of sustainability (This thesis).

2. Improving the stability of the agricultural landscape should be an integral part of pest management. The focus should be on prevention of out-breaks rather than crisis management once pest problems have occurred (Altieri, 1995:268. Agroecology: the science of sustainable agriculture. Westviewpress).

3. An appropriate solution to the Blackbird problem was possible once the causes had been successfully identified (This thesis).

4. The increase in the Blackbird population can be considered a symptom of an environmental imbalance (This thesis).

5. It is time to address the needs of the poor in developing countries. It is immoral that they go hungry while food and resources are exported [inexpensively] to developed countries to pay for expensive technologies and loans.

6. Never tell a lie unless you can prove it (Millor Fernandes).

TABLE OF CONTENTS

Glossary & abbreviations

AKIS	Agricultural Knowledge and information Systems (Engel et al., 1995)
Banco do Brasil	Brazilian National Bank
BB	Blackbird
CITES	Clube de Integração e Troca de Experiência (Clubs for integration and exchange of experience)
CPACT	Centro de Pesquisa Agropecuária de Clima Temperado (The Agricultural Research Centre for the Temperate Climate Region). It is part of the Brazilian Enterprise for Agricultural Research (EMBRAPA)
CPALS	Commissão de Pesquisa em Sistemas Ambientais do Litoral Sul do Rio Grande do Sul - (Interinstitutional Research Committee in Environmental Systems of the Southern Shores in the State of Rio Grande do Sul)
EMATER	Empresa estadual de assistência técnica e extensão rural (Enterprise for Technical Assistance and Rural Extension)
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Enterprise for Agricultural Research). It is linked to the country's Ministry of Agriculture and Agricultural Reform (MARA)
EXTREMO SUL	Cooperativa arrozeira Extremo Sul (Rice farmer cooperative Extremo Sul)
FARSUL	Federação da Agricultura do Rio Grande do Sul (Rio Grande do Sul Agricultural Federation)
FEDERACITE	Federação dos Clube de Integração e Troca de Experiência (Federation of Clubs for integration and exchange of experience)
FEDERARROZ	Federação das Associações dos Arrozeiros do Rio Grande do Sul (Rio Grande do Sul Rice Farmers Federation)
FEPAM	Fundação Estadual de Proteção ao Ambiente Natural (Rio Grande do Sul State Institute for the Environment)

FURG	Fundação Universidade de Rio Grande (University of Rio Grande)
FZD	Fundação Zoobotânica (Institute for Natural Resources of Rio Grande do Sul State
Granja Branqueada do Salso	A rice farm belonging to the Correa family. It is located in Rio Grande County and grows 250 ha of rice. It is considered to be a small rice farm for the region.
Granja 4 irmãos	This is a rural enterprise named the four brothers. It belongs to the Oliveira family and is located in Rio Grande County. The farm grows 5000 ha of rice and is considered a big rice farm for the region.
Grupo pré-germinado	A study group of farmers interested in integration and exchange of experiences, related with rice water-seed system.
IBAMA	Instituto Brasileiro do Meio Ambiente (Brazilian Institute for the Environment)
IBGE	Instituto Brasileiro de Geografia e estatística (Brazilian Institute for Statistics and Geography)
IPAGRO	Instituto de Pesquisa Agropecuária do Estado do Rio Grande do Sul (Rio Grande do Sul State Institute for Agricultural Research)
IRGA	Instituto Riograndense do Arroz (Rio Grande do Sul Rice Institute)
Knowledge and Information System	KIS is an articulate set of social actors, individuals, organizations and/or institutions that emerge as a result of networking for innovation. All actors in a KIS, engage in generating, sharing and using knowledge concerning a certain domain of human activity. Their learning is intrinsically related to daily practice. Therefore, a KIS consists of multiple knowledge networks and an application of different types of knowledge and information to the innovation process. Researchers contribute 'scientific knowledge', farmers contribute 'practical knowledge', policy makers 'policy-related knowledge', traders 'commercial knowledge', etc. Innovation emerges out of this process (Engel et al., 1995).

MARA	Ministério da agricultura e da reforma agrária (Brazilian Ministry of Agriculture and Land Reform)
MBRM	First Meeting on the Blackbird and its interaction with the rice culture in the MERCOSUL countries
RAAKS	Rapid Appraisal of Agricultural Knowledge Systems is a methodology that takes the social actors in a theatre of innovation through a deliberate interactive process during which they learn to become a soft system.
SDR	Secretaria de Desenvolvimento Regional (Regional Development Secretariat)
SSP	Systems perspective, focussed on sustainability and participatory action approach.
UCPel	Universidade Católica de Pelotas (Catholic University of Pelotas)
UFPel	Universidade Federal de Pelotas (Federal University of Pelotas)
UNISINOS	Universidade do Vale do Rio dos Sinos (Vale do Rio dos Sinos University)

List of Figures

List of Maps

List of Diagrams

List of Tables

List of Boxes

List of Photos

ACKNOWLEDGENTS

This study is indebted to a wide range of people and organisations. They co-operated in this research right from the beginning and are listed below.

EMBRAPA (Brazilian Enterprise for Agricultural Research)

University of Rio Grande

Catholic University of Pelotas

Rio Grande do Sul Rice Institute

Brazilian Institute for the Environment

CITE 01 and 55 (Study clubs of rice farmers)

Water-seed farmers group

Rice farmers co-operative Extremo Sul

Branqueada do Salso farm

Quatro Irmãos farm

Wageningen Agricultural University

International Centre for development oriented Research in Agriculture

Daniel Franco, Maximiano Cirne, Augenor Gomes, Irajá Antunes, Fetter Jr., Rubens Corrêa and Christina Auerback.

Prof. Eric Goewie and Milton Asmus

All those contributed to made my research successful and most pleasant. I thank them all for their help, their patience, discussions and time. Due to them, Brazil got new insights about systems research. There is also another group of people who deserves my feelings of thanks and gratitude. I could not have done this work without the support and understanding of my family. Those are my two kids, Juliana, Alonzo and my wife Marta. You supported and encouraged me and above all, you gave me rest and hope...you are so beautiful. I hope that this work will make you as proud as I am...and forgive my alienation for the past 7 years. Finally, I dedicate this thesis to my parents, Orivaldo and Carmen. No matter where you are, I know that you were always by my side.

1. INTRODUCTION

The Blackbird (*Agelaius ruficapillus*) was a protected animal in the State of Rio Grande do Sul until 1998. It is however, a serious pest in rice producing farms. Many control strategies are not legal or have not been proved to be effective. Rice farmers are desperate. An efficient and effective method, acceptable for farmers, environmentalists and nature conservationists, should be found. This thesis presents such a method.

That method is the result of long-term research carried out in close cooperation between rice farmers, supported by a multi-disciplinary team of scientists. Farmers in question seem to be happy with that method. It has been found to be applicable, cost reducing and image improving, making it acceptable to both the farmers in question and also environmentalists and nature conservationists.

Chapter I provides a detailed picture of rice production in Rio Grande do Sul State, identifies the nature of the Blackbird problem and highlights the importance of finding a long-term solution. Chapter 2 continues by analyzing the damage done by Blackbirds and examines the role of the seasons and geographic factors as well as relevant efforts undertaken to combat these. This has been studied on the basis of literature and/or experience and serves to highlight the problem, raising the scientific questions to be addressed by research.

Research concerning sustainable Blackbird control in rice, is not achievable in controlled field experiments or the laboratory. It is difficult to create population densities of birds, sufficiently harmful for rice production under experimental conditions. Nor is it reasonable to measure the effectiveness of various Blackbird control scenario's, in limited and conditioned, experimental plots. Our research could only be done on the farms themselves, along with all the variations, disturbances and differences in farm management. This was acceptable, since for the benefit of farmers and consumers, our priority was to identify the means of solving the Blackbird problem and not merely demonstrating the fact that the Blackbird is a major pest. So, our question is not discovery-oriented, but invention-oriented, namely a method for sustainable and persistent control of Blackbirds in rice, managed by farmers at farm level. That is why we adopted agronomical designing methods, a type of participatory technology development (PTD), as a basis for setting our research agenda (Goewie, 1999).

Two questions arise. Firstly, how to find solutions at various levels of aggregation [i.e. at crop, field, farm or regional levels] and secondly, how can these solutions at different levels be integrated successfully? Both questions require a theoretical framework in order to elaborate the research process.

Chapter 3 identifies designing objectives at four levels of aggregation: crop, field, farm and region. Each level can be considered as a study in its own right. Results obtained from each of these studies are components of the ultimate solution: a sustainable control of the Blackbird in rice. The phases of the research journey are addressed in detail.

Chapter 4 introduces AKIS, the Agricultural Knowledge and Information Systems in relation to the Blackbird problem. Chapter 5 presents the identification of the problem and its causes. Chapter 6 discusses options for practical implementation. Implementation of the management program is outlined in chapter 7. Chapter 8 evaluates the BB research project in light of critical success factors and also addressed the implications of the research project for farmers, organizations and their staff.

1.1. The environment of the thesis field work

- **The region**

The State of Rio Grande do Sul is situated between the parallels 27°03'42" and 33°45'09" South, and the meridians 53°03'24" and 53°23'22" West and covers 282.184 Km^2. According to Rambo (1994), the climate of this region is temperate humid. Annual rainfall and temperature averages 1200 mm and 20°C respectively (IBGE, 1986). According to Silva and Caye (1992), Rio Grande do Sul harbors 479 species of birds distributed among 73 families. Rice is cultivated in two dominant ecosystems in the region: plateaus and the plain or low lands. Plateau and plain (Table 1) have rice agro-business as their main economic activity. Although they represent only 20% (one million ha) of nation's acreage of rice, they produce approximately 4,6 millions tons per year — more than 54% of total Brazilian rice production (Azambuja et al., 1996; EMBRAPA-CPACT, 1993; Vieira and Rangel, 1993; Vieira and Rangel, 1984).

Table 1. *Main characteristics of rice production areas of Rio Grande do Sul (EMBRAPA-CPACT 1993)*

ECOSYSTEM	area (Km^2)	RELIEF	ALTITUDE (m)	VEGETATION	HYDRIC RESOURCES
PLAIN					
-CENTRAL	30.000	soft undulated	<100	secondary and pasture	abundant
-COASTAL	48.000	flat	<50	swamps	abundant
PLATEAU					
-CAMPANHA	30.000	flat-undulated	50-200	bush	limited

- **Research area**

Rio Grande county was selected as the area of study on how to solve the Blackbird problem. The selection was done during a workshop in 1993. Rio Grande county is located in the plain coastal area of Southern Brazil, between 31°47' 02" and 32°39' 45" S, and 52 ° 03' 10" and 52 ° 44' 10" W (Map 1). Climate of the Rio Grande county varies from humid to sub-humid (IBGE, 1986), with an average annual rainfall of 1161.8 mm and an annual average temperature of 18.1 °C (Table 2).

Table 2. *Rio Grande county average temperature and average rainfall (CLIMANÁLISE, 1986)*

	SUMMER	AUTUMN	WINTER	SPRING	ANNUAL
Temperature (°C)	22,8	19,1	13,3	17,1	18,1
rainfall (mm)	246,7	298,6	328,4	288,1	1161,8

Five different types of landscape ecosystems are identified in Rio Grande county (Table 3). Those types differ from each other because of their geomorphological, hydrological and vegetational characteristics. Some are of anthropomorphical origin [i.e. crops and pasture]. Veiga et al. (1995) found a very diversified fauna in Rio Grande landscape ecosystems. Concerning birds, 236 species could be identified, among which 91 species are especially related with rice crops. The same figures were found for the low lands of Uruguay (Rodriguez et al., 1995).

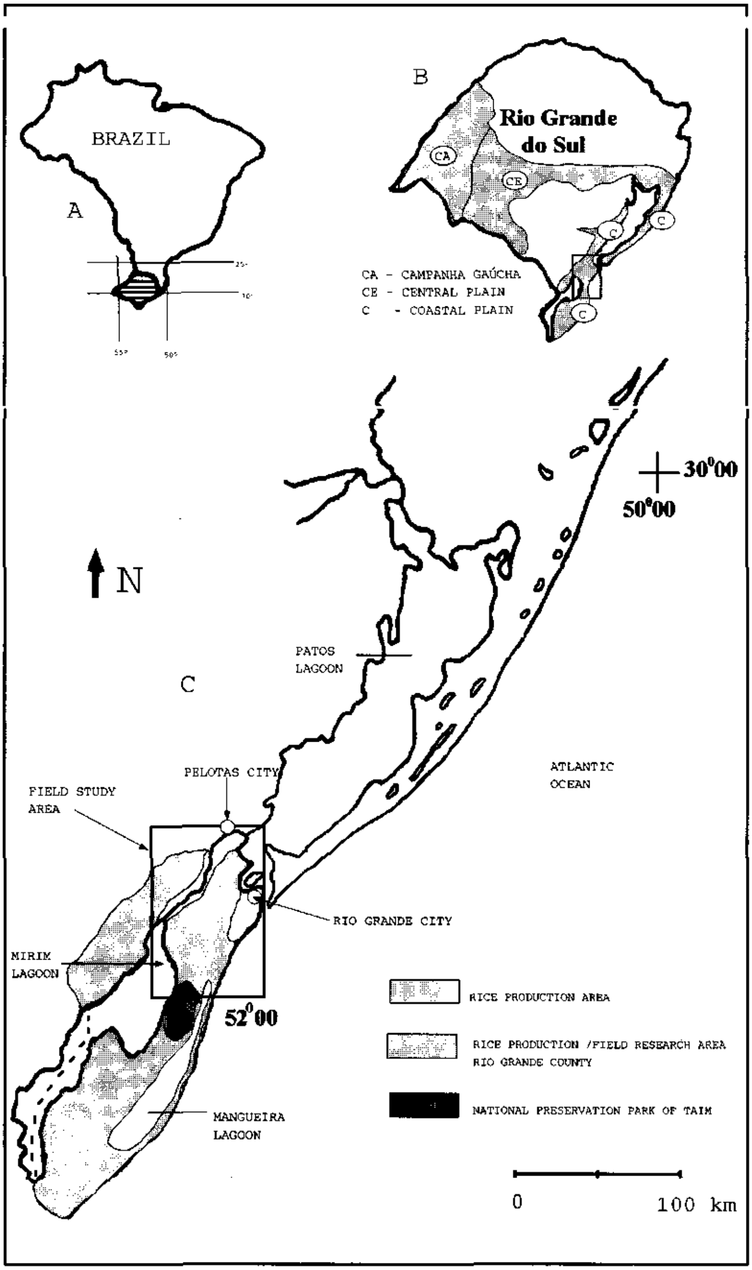
Table 3. *Surface of five main landscapes of Rio Grande county (Tagliani, 1997)*

	ha	%
Swamps	64562	12,68
Water	237275	46,60
Native and planted forest	10054	1,98
Crops and pastures	63025	12,38
Others (Dunes, salt marshes, urban area, horticulture)	134239	26,36
Total	509155	100,00

The economy of Rio Grande county is almost exclusively based on agriculture. Technologically driven rice production occurs on 30.992 ha which covers 90% of farm land in Rio Grande. Mixed production (rice and cattle) is the main commercial option for profitable agricultural activities in the region (IRGA/NATE, 1993; IRGA/NATE, 1997; ITEPA, 1996; ITEPA, 1997).

Photo 1. Swamp (Rio Grande county, Brazil, 1998).

Photo 2. Rice field (Rio Grande county, Brazil, 1998).



Map 1. *Geographic position of Brazil (A), Rio Grande do Sul State (B) and the study area in Rio Grande county (C).*

- **The rice farmers**

The official land distribution in Rio Grande do Sul began in 1737. At that time a huge area was distributed to just a few farmers. Besides their extensive husbandry activities, they also functioned as protectors of borders, most of them with a military status. Supported by the Government and Catholic Church, those 'farmers', after a few years, became important social actors in regional development (Vieira and Rangel, 1985; Vieira and Rangel, 1993; Quadro, 1995). Colonel Pedro Osório, one of the biggest farmers of Rio Grande do Sul, introduced irrigated rice in Pelotas, Rio Grande do Sul in 1906 (Lopes, 1914; Fraquelli, 1993). Due to his excellent profitable results, rice production spread all over the region immediately. From that time on, rice production became associated with big farmers. With a privileged economic and political situation [threatened just recently by globalization trends (Gasparotto, 1997; Porto, 1996)], the rice farmers have access to and are able to apply new technologies. Rice farmers of Southern Brazil are considered to be great examples of technological innovators of Brazil (Ribeiro, 1996).

- **The rice farm**

Until today, we can still find farms of some thousands of ha in Rio Grande. However, their number has decreased due to fragmentation of land as a consequence of inheritances within families. Most of the big farms have rice and livestock as their main enterprises. Rotation of rice, every two years, is the common practice in the region. During the period when rice is not cultivated, the area is used as natural pasture for cattle[1].

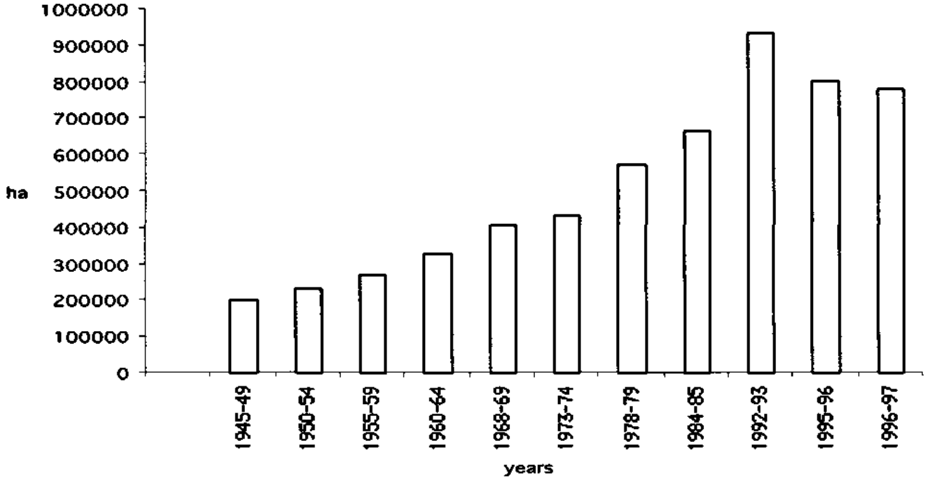
A rice crop takes just 10 to 25 percent of farm land. This low utilization of land is due to several reasons. The main ones are as follows: a) Irrigation is not possible where the topography of the land is irregular; b) where there is a lack of sufficient water available within the farmer's property[2]; c) a rice irrigation system (energy, equipment, labor, and, maintenance of channel irrigation systems) is expensive [3]; d) some land is protected by law [i.e. swamps which may affect certain farms]. However, the main cause of reduction of rice production area in Rio Grande do Sul State, is due to limited private capital of the farmers themselves (Figure 1). The agricultural subsidies awarded during the 70's and 80's by the Brazilian Government are no longer available and farmers are now fully dependent on the profitability of their production.

[1] According to researchers and farmers of Rio Grande do Sul State (personal communication), crop rotation is the best way to prevent diseases and weeds. At the same time, soil has its chemical, physical, and biological characteristics improved due the root system of pasture and manure from cattle.

[2] Rice production needs approximately 13.000 m^3 of water/ha during 80 to 100 days (Gomes et al., 1996; Vianna, 1997).

[3] US$ 216,00, or 18% of rice production costs concerns costs of irrigation (Corrêa et al., 1997) — US$ 70,00 concerns the 1.100 kWh/ha for electrical energy involved by irrigation (Vianna, 1997). Rice production of 5 to 6 tons per ha costs the farmers about US$ 1190,38 per ha (Rucatti and Kayser, 1996).

Figure 1. *Evolution of the rice area (ha) in Rio Grande do Sul State. (Anuário Estatístico do Arroz, 1988; IRGA-NATE,1993-1997).*



Large and small farms might differ in profitability. In Europe and The United States, official agricultural policies are based on the perception that large farms are more profitable than small ones. Large farms usually profit from their economy of scale. Rice production in Rio Grande do Sul State seems not to be in line with those perceptions. Zaffaroni et al. (1997) found no statistical difference between large and small rice farms when the parameters of appropriate housing, availability of communication systems, technical assistance, technology and reasons for production of rice as commodity, were taken into account. However, differences could be identified when the parameters were level of owner education, kind of association, land ownership, opportunities for cattle production, availability of seasonal labour and appropriate machinery. The later parameters are less related with economies of scale than the previous parameters. The conclusion amongst farmers, based on RAAKS methodology (Engel et al., 1995), is that each farm has its own infrastructure concerning production[4]. Box 1 shows characteristics of a typical 1500 ha farm, according to the farmers involved in the project.

Box 1. *Characteristics of a typical 1500 ha rice farm according to farmers involved in the Blackbird project.*

10 to 15 employees
400 ha of rice and 700 head of cattle
400 ha of conserved natural area*
100 ha as reservoir
30 ha of Eucalyptus wood
20 ha of corn
50 ha of winter pasture.
*Most farms involve lands with special values from a nature conservation point of view. These are protected by law and can not be used for agricultural purposes (e.g. swamps).

[4] Stocking and processing, land preparation, sowing and harvest machinery, irrigation infrastructure, employees, house, radio or telephone communication, and computer software for administration, varying proportionally to the size of farm involved.

The rice crop

The average production in Southern Brazil is 5,2 tons per ha. This is one of the highest in the World (Table 4). Yields of 10 tons per ha have been recorded. These results are due to wide spread utilization of high technologies (computer software, laser land leveling equipment, aircraft, field mechanization, and stock systems) and a high input of chemical fertilizer, pesticides, oil, electric energy, and labor.

There are four main different systems of irrigated rice cultivation in Rio Grande do Sul State: conventional (73%), non-tillage and minimum tillage (25%), and water seed (2%). The systems differ from one another by soil preparation, sowing processes and initial water management. The conventional system has as its main characteristic the ploughing process, which is the opposite of no-tillage and minimum tillage. The water seed system has as its main characteristic, sowing of pre-germinated seeds into a 10-cm water layer (Gomes et al., 1996).

Table 4. *Mean rice productivity (ton/ha) in the World*

Region	ton/ha
Southern Brazil (Rio Grande do Sul and Santa Catarina States)	5.2
Latin America	3.1
North America	5.6
Asia	3.8
Africa	2.1
World	3.7

source: Sanint, 1997

1.2. Rice production and its meaning for Southern Brazil

Rice is one of the main components of the Brazilian diet. Average consumption is 44 kg/person/year. In Rio Grande do Sul State more than 450 rice mills process grains and oil for human consumption, 'quirela' (broken rice) for animal consumption and raw material for breweries. The 15.000 rice farmers in the region are responsible for 240.000 jobs (production, industrialization and commercialization) (Azambuja et al., 1996). The rice production sector of Rio Grande do Sul contributes 1,6 billion US dollars to Brazil's economy per year. That sector pays about 149 million US dollars in tax to the government (FEARROZ, 1995).

1.3. Rice production and its meaning for local farmers in Southern Brazil

All big farmers concerned, agree that rice/livestock-farming systems are the best and most suitable profitable option in the low lands of Rio Grande do Sul State. Other options, such as farming systems based on soybean, corn and sorghum, have been developed and proposed by research institutes. However, farmers are not convinced about the profitability involved. They argue that natural and environmental conditions, such as hydromorphic soils, humid climate, abundant hydric resources and plain relief of farmland are excellent for rice. Those conditions perfectly fit into governmental policies, directed towards food security, but also into the role of rice/cattle as a buffer between supply and market prices. Those arguments makes rice production less costly and thus profitable. Other reasons for their resistance against alternative farming systems [apart from the cultural aspect] are presence of expansive argyles, making soil management difficult and the land with a poor soil fertility status. Additionally, investment for drainage (e.g. for corn production) or absence of a stable market (e.g. for sorghum) plays an important role. If the Brazilian economy improves, options other than rice/cattle might receive renewed interest.

1.4. The future of rice production in Southern Brazil

Rice production in Southern Brazil was very profitable until quite recently. But due the current governmental policies that extinguished all subsidies and opened the country for globalization, profit margins have narrowed. During the 70's, Government strategy was directed towards national rice production and buffering stocks. In that time, the Government used to subsidize rice production, stocking and industrialization. Today, in order to reduce its internal deficit and keep the rice at a low price at consumer level, the Government put an end to all agricultural subsidies and allows rice mills to import cheap rice from countries in which production and exportation is heavily subsidized. In the commercial year of 1996/97, a 692.715,09 tons of rice were imported by Rio Grande do Sul private mill (Rucatti and Kaiser, 1997). That market competition has caused commercial difficulties for the Rio Grande do Sul rice farmers. Sometimes, they had to sell their rice for prices below production costs, otherwise they would have lost their market.

Governmental policies for the rice sector probably will be maintained. The future of rice farmers will depend exclusively on their capacity to compete with imported rice, in terms of market price. Of course, a good price/quality ratio should play a role as well. In case we (farmers, technicians and Government) are incapable of overcoming this situation, an economic and social crisis resulting from the rice farmer's bankruptcy will take place in Southern Brazil. The immediate consequence of this will be the aggravation of the exodus (World Bank, 1990) of rural workers into the cities.

1.5. Articulation of the problems for rice farmers in Southern Brazil

In order to maintain their competitiveness against the rice imported by the Government, rice farmers concerned tried to keep up their productivity and, at the same time, reduce the production costs to a minimum. They achieved this by reductions and optimization of labor and inputs. With such measures, farmers got a profitability of approx. 10% of the production cost at best. In contrast with Europeans farmers, the majority of Brazilian farmers did not improve their profitability by increasing their output. But decided to reduce their costs. This can be understood for two reasons. Firstly, European commodities are heavily subsidized while Brazilian farmers have to react at their market demands, which tends to suppress market prices. Secondly, enormous investments are necessary to maintain a production level of 5,2 tons/ha. Most farmers depend on private capital or funds with advanced interest rates (sometimes up to an 8% per month). For these reasons it can be seen that striving for increased output marginalizes profit quickly.

With little room for maneuvering, and attempting to keep up levels of production less importance is given to environmental issues. Although the need for protection of the environment is appreciated by farmers, the main priority at present, is one of economic survival. The need to find a solution to the threat caused by the Blackbird on rice productivity is becoming more and more important. Blackbirds contribute to further marginalization of rice farmer's profitability. A decrease of 10% of productivity may result in complete loss of profitability.

1.6. Problem identification

In 1992 the Rice Farmers Association formally requested official research institutions to solve the Blackbird problem. According to farmers and the extension service, the Blackbird population had risen so drastically that it is now considered a pest. Blackbirds take freshly sown seeds and sprouts, break stems and eat ripening rice or knock it to the ground.

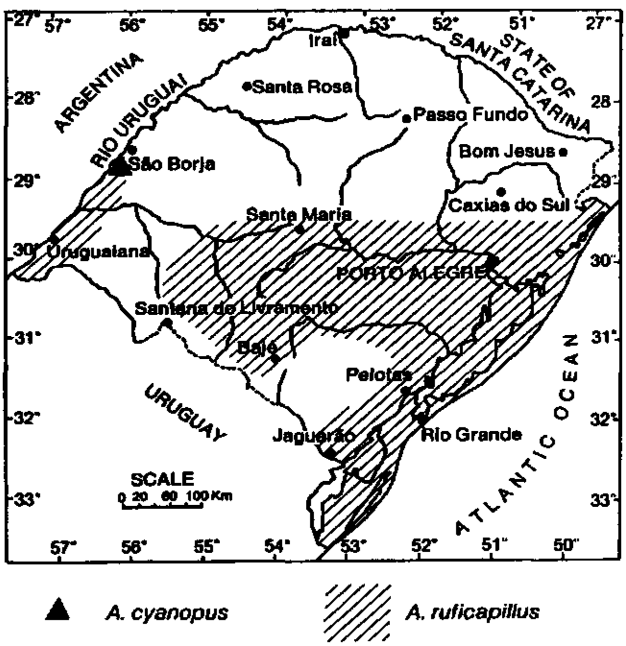
Due to the current economic situation and narrowing profit margins, Brazilian rice farmers have given control of the Blackbird a high priority. Efforts like sound alarms, fireworks and scarecrows have failed. Since the Blackbirds became used to them very quickly (Belton, 1985). An agronomical solution, such as delayed sowing is not possible due to the advent of the rainy season before harvesting. Seed treatments and toxic baits were not successful either and are now banned from use in Brazil because of mortality in non-target species.

The challenge now is to manage the 'conflicting objectives and interests' between farmers and environmentalists. These conflicts result from differing opinions, appreciation and definitions of the problem and the possible solutions involved.

2. THE BLACKBIRD PROBLEM
2.1. Description of the problem in time and space
2.2. Results and solutions so far
2.3. Assignment from the Brazilian Government
2.4. The problem as a scientific question

2.1. Description of the problem in time and space

According to Belton (1985), *A. ruficapillus* —one of the most abundant species in Rio Grande do Sul — wherever rice is cultivated and is widely spread in the lowlands (Map 2). According to personal testimonies from local farmers and extensionists, the Blackbird population has risen alarmingly since the 1980's with no sign of stabilization.



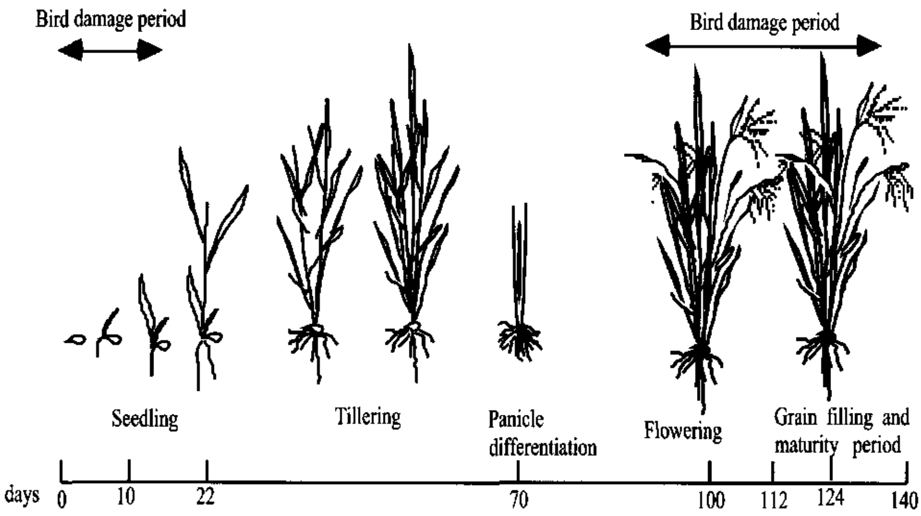
Map 2. *Geographical distribution of two species of Agelaius in Rio Grande do Sul (Belton, 1985)*

Blackbird damage was small at the beginning of this century. Cultivated rice was introduced in Rio Grande do Sul in 1821 (Saint-Hilaire, 1987). But it was only form 1906 that reports of rice damage began to occur (Lopes, 1914).

By the time this research commenced, the problem was extreme. The Blackbird population density had increased tremendously and in some parts of Southern Brazil, rice production was practically impossible. According to rice farmers and the Extension Service, damage was already occurring during the rice sowing period of Oct-Dec and this was the case every year.

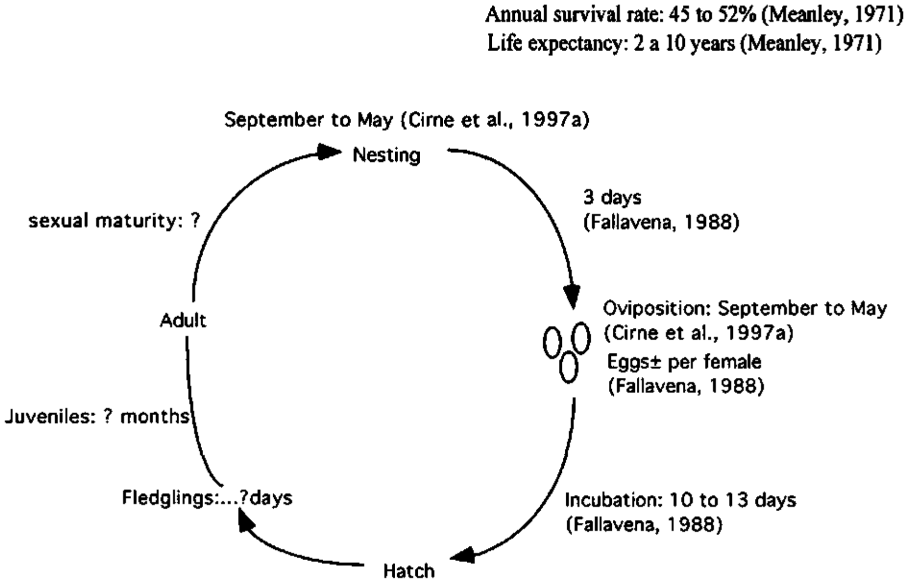
Flocks of Blackbirds vary in size from 20 to thousands of individual birds. They take the freshly sown seeds and pull sprouts out. In same cases, as in the water-seed system the attack is so intensive that it is necessary to re-sow. During the rice maturation period, birds suck grains during the 'milk' phase, and eat them during the 'mass / soft dough' and 'ripe/ hard dough' phases. At the harvesting period, apart from eating the rice, the birds break plants and knock grains to the ground, increasing the damage. A schematic presentation of the rice plant development cycle and the period of Blackbird damage to rice crop can be found below in figure 2. Figure 3 presents the blackbird life-cycle.

Figure 2. *Rice plant development (variety BR-IRGA 410) and Blackbird rice damage period in Southern Brazil (Galli et al., 1985; Infeld, 1988)*



Sowing period: from October, 15 to December, 10
Harvest period: March to May

Figure 3. *A. ruficapillus life-cycle in Southern Brazil.*



2.2. Results and solutions so far

Until recently, no agricultural research activities have been carried out on this subject in Brazil. The ecological aspects of this species are largely unknown. Only one brief study exist (Fallavena, 1988). Consequently, the bird was not recognized as a pest by the Brazilian Institute for the Environment and control was not allowed. Finally, on 26.05.98, the regulation 63-N was published by the Institute which states that *A. ruficapillus* is now considered a pest for rice production and included aspects relating to population control.

Environmentalists warned that application of toxic baits could result in mortality of non-target species associated with the rice crop — there are in the region 236 species of birds (Veiga et al. 1995). Their concern is justified, considering studies such as the one conducted by Flickinger et al. (1980; 1984; and 1986) about the mortality of birds and other animals due to the use of carbofuram and organophosphorated pesticides in rice fields.

Discussion about the damage in rice, caused by Blackbirds resulted in conflict between rice farmers and environmentalists. Controversy increased due to lack of information. Farms could not show data demonstrating that blackbirds are pests, yet this data was essential if environmentalists and the Brazilian Institute for the Environment were to formulate options for control with minimal negative environmental effects.

2.3. Assignment from the Brazilian Government

Over the last 15 years, there has been a steady development in procedures for a particular kind of agricultural research, currently called client-oriented research. According to Merrill-Sands et al. (1991) and Mettrick (1993), researchers must understand farmers production systems and be responsive to the goals and priorities of the farmers they are serving. However, clients are not just farmers but society as a whole. Engel et al. (1995) point out that innovation must be seen as a social competence shared among all individuals, institutions and organizations.

As a result of the recent reorganization within the Agricultural Research Centre for the Temperate Climate Region (Box 2), institutional research shifted from disciplinary research towards problem-solving research.

Box 2. *CPACT-EMBRAPA (EMBRAPA-CPACT, 1993)*

The Agricultural Research Centre for the Temperate Climate Region (CPACT) is part of the Brazilian Enterprise for Agricultural Research (EMBRAPA), which is linked to the country's Ministry of Agriculture and Agricultural Reform (MARA). In 1993, the CPACT emerged from the integration of two research centres in Pelotas, the Agricultural Centre for the Lowlands (CPATB) and the National Research Centre for Temperate Fruits (CNPFT). The new institute (CPACT) has a regional jurisdiction, and is designated as an Eco-regional Reference Centre. Such centres are research units where technologies are generated for direct use in the ecological macro-region of the temperate climate zone of Southern Brazil (the states of Rio Grande do Sul, Santa Catarina and the Southern part of the state of Paraná, between 23°30' and 33°45' South, corresponding to 476,000 Km^2).

OBJECTIVE OF CPACT

To generate, adapt and diffuse technologies related to the management of natural resources and production systems in temperate climate regions. These activities aim at the sustainable development of the agricultural sector, and (in a broad sense) of society.

Therefore, CPACT is responsible for:

* characterizing, monitoring and evaluating environmental resources in the temperate climate regions;
* generating technologies to enhance the efficiency and quality of the agricultural production systems; and
* efficiently transferring the generated technologies, satisfying the demands of society.

Under this "new" problem-oriented research approach a project was initiated in CPACT to study the Blackbird problem. In this project, attention has been given simultaneously to the agronomic aspects related to the damage caused by the Blackbird in the rice crop and to the protection of the environment.

2.4. The problem as a scientific question

Rice farmers in Rio Grande do Sul do have a problem. This demands an acceptable solution. Scientific research is needed. This research could start with examining the nature of the farmer's problem. Is the problem a real problem or what is the cause of the problem? The other approach would be to get a better understanding of Blackbird phenology. Traditional scientific approaches tend to bring the problem back to a dimension which makes experiments achievable. This might induce knowledge of scientific value, but does not result in a solution that is directly applicable for farmers. Another question concerns how to experiment with birds at conditioned experimental fields of limited size? Experimental research seems not to be able to raise an answer acceptable to farmers. Another approach concerns on-farm trials managed either by researchers and farmers (Mettrick, 1993). Results, thus obtained, might be closer to farmer's experiences. Vijverberg (1996), Van der Ploeg (1994), Hamilton (1995), show how successful on-farm research can be. Goewie (1993) states that science related to modern farming is restricted to much by economic objectives. Farmers have lost their position as farm managers. They have become dependent on scientists outside their agro-ecosystem. Sustainable solutions for controlling Blackbirds should include education and information for the farmers to improve decision making capacity, a necessity in ever increasingly complex farm systems. So, solving the Blackbird problem by science, needs an agronomic design approach (Altieri, 1995). The solution must address economic consequences to the farmers and also environmental demands, by raising agronomical and technological measurements, with the scope of an applicable decision support system (Mettrick, 1993).

Three [main] pest control approaches can be highlight. The first approach focuses on better labeling, training, safe forms of application, recollection of packing material, and so on, to reduce unnecessary emissions and health accidents (Noé Pino, 1989). The second approach is biological pest control and organic agriculture which entails a combination of agronomic measures and the use of 'bio-pesticides', which contain pest-reducing substances. The third approach, integrated pest management (IPM), studies natural enemies of pests in order to avoid calendar spraying. A key concept is 'economic thresholds', which is the pest population density at which the cost of application equals the value of the crop saved by controlling the pest (Hruska, 1990; Altieri, 1995). IPM may include biological control as well as pesticide use.

All the three approaches as mentioned above tend to address the pest itself and not its cause. [Currently] IPM and biological control strategies are substitutions of pesticide applications in fact. Causes, like high production aims or removing all biotic and abiotic diversity at, and around production sites, hardly play a role. IPM and biological control strategies seem not to be appropriate methods for Blackbird control.

Table 5 summarizes retrievable literature concerning Blackbirds and rice. Only a few publications could be found about *A. ruficapillus*. However, literature about related species might be of interest as well. Table 5 shows to what extent various subjects related to Blackbird control in rice were studied. It became obvious that the Blackbird problem in rice production was addressed in exactly the same way as problems with common plant pests. The pests themselves got much more attention than the causes behind the pest explosion.

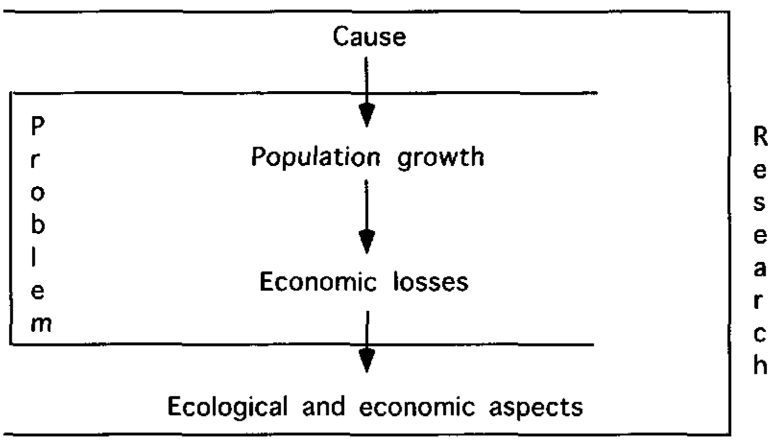
Table 5. *An overview of different subjects identified in literature about "Blackbird and rice production". The ordinate shows categories of subjects in relevant literature. The abscissa indicates categories(n.) per year. Sources are identified by numbers between brackets in references.*

Subjects covered																										Total
net trap	1																									1
rifle/hunting				2	1											1		1					1	1	1	8
cultural practices				1																1			1		1	4
timing the crop				2												1	1		1	2			1		1	9
poisoned baits		1		1	1								1			1		2					1		2	10
increase the seeding rate																				1			1		1	3
plant breeding				1				1												1						3
automatic exploder/fireworks				2	1											1				1				1	1	7
scarecrows/moving objects				1	1																		1			3
sound devices				2	1																			2		5
repellent			1	4	2			1		3		2	1	2	2	1		1	1	3		1	1	3	2	31
chemosterilants					1																					1
clear bush/nest destruction	1			2			1													1			1		1	7
trap crop																				1						1
costs for control				1								1				1							1	1		5
damage	1		2	2	3	1	1	1		3		2		2	1	2	1		2	4			1	2	3	34
food/consumption/preference	1		1	1	1			2	1		2	1			1	2	1	1		3	1	1	1	3	3	27
ethology	1			2							1	1						1						1		7
reproduction	1						1	1			2	1			2			1		1						10
causes of the population growth																										
population studies	1			2	2			1							1				1	3	1	1			1	14
other birds assoc. with rice								1								1		2				1		1	2	8
general biology	1			1				1		1	1	1		1	2			1			2				1	13
ecotoxicology/chemical control										2	1	1	3		4	1		3						1	1	17
taxonomy/description	1			1						1											1					4
Total	9	1	4	28	14	1	3	9	1	10	7	10	5	5	13	12	3	13	5	22	5	4	11	16	21	232
Years (19…)	50	68	70	71	73	75	76	77	78	79	80	82	83	84	85	86	87	88	89	90	91	92	93	94	95	
Source	23	37	33	43	14	39	21	1	25	13	2	3	31	45	4	22	42	16	5	7	34	8	9	6	11	
			38	44	15			24		54	30	47	66	71	12	32	78	27	75	19	48	20	64	10	17	
				52	18					55	67	53	77	72	26	36		29		28		62		35	46	
				61	40					56					57	68		69		49				51	50	
					41										73	74		70		60				58	59	
					63															76					65	

From table 5, we may conclude that the Blackbird problem has been reduced to a simple experimental question: how could it be killed? Researchers seemed to have lost the distinction between cause and effect. Dominant research strategy was oriented to its nature as pest. The strategy of this thesis should be cause-oriented. Or in other words: how to eliminate field/farm conditions favoring the increase of Blackbird's population density during rice production seasons, by improving farm structure, farming style and farm management?

Facing the problem we identified two key questions: the problem as such and the research process related with finding solutions for removing the cause of the problem. The first key question should address the relation between population density and loss of economical perspectives of rice farms. Economical damage for the farmers must be expressed in simple criteria: at what population density does the Blackbird cause economic damage? The second question should find the solution on how to remove population density stimulating factors (Tripp and Woolley, 1989). The cause of the Blackbird problem might not be restricted to simple farm boundary and agronomical analyses. The problem may originate from processes occurring an a much wider scale, possibly whole regions or even the whole State. This would naturally involve not just farmers but many nature conservationists and environmentalists. So, due to the complex situation we had to structure a research process. Figure 4 shows our strategy in main lines. By keeping boxes in figure 4 open I want to represent the idea that in order to solve a problem, researchers have to consider inter-relations among cause, problem and consequences of any solution (in this case: ecological and economical aspects). Now, various analysis methods could be applied: cause-effect models, interaction level diagrams, conceptual models and simulation models. All results were integrated in our own way. We called our integration method "boundary analysis".

Figure 4. *The general structure of this research: Both boxes are half opened, in order to show that inter-relations "among problem, cause and solutions must be possible all along the research process".*



In conclusion: our research aims to give scientific answer to the following question.

Rice cropping in Rio Grande do Sul State has increased in area steadily since its introduction in the state (Figure 1). Yet, an exaggerated increase in the *Agelaius* population could be observed only recently. According to Belton (1985) its population rise did not coincide with the rice growing area in Rio Grande do Sul State. So the question is: What factors led to the sudden increase of this species, inducing a tremendous economical problem for the rice farmers?

By finding the answers to this question it shared then be possible formulate a plan of operations which sustains restoration of the natural population density, as well as rice cropping systems free from damage by Blackbirds.

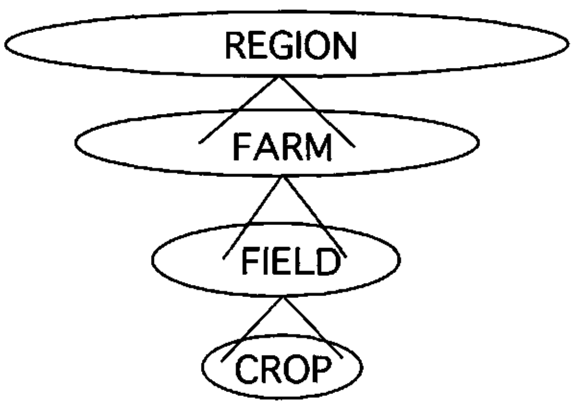
Searching for prevention in stead of eradication of the Blackbird is supported by ideas of Capra (1982), (Little and Geer, 1994) and (Altieri, 1995). Based on their ideas, one should consider pests in agriculture as a manifestation of unbalanced agro-ecosystems or a destabilized natural environment. Howard (1910), cited by Rodale (1946) said, "pests should be considered as an agricultural teacher from nature". Therefore, the Blackbird can be considered as indicator of disturbances [that are man-made]. These disturbances induced a variety of factors responsible for the appearance of the Blackbird as a pest. Our suggestion means that small actions can be sufficient for getting big effects on these mechanism.

To conclude, our general assumption states that if we want an appropriate solution for our Blackbird problem, then it is necessary to identify the problem and its causes. Therefore, it is essential to identify 'why' the pest occurs and not just identify 'how' to destroy the birds. It means, conceptually, that knowledge about the origin of the pest should precede knowledge about the nature of damage in rice. However, how could we find the answer methodologically? Chapter 4 (Getting in touch with the problem) sets the objectives to be achieved after finishing this project.

3. THE RESEARCH PROCESS

The Blackbird problem had to be researched at four levels of aggregation: crop, field, farm and region (Figure 5). We found that within the scope of our problem, it can never be the researcher alone who determines the course of the research program. Besides his own influence, the influence of farmers at which farms the study has been performed, as well as the history and future of the region in question, cannot be excluded as determining factors. This means that it is difficult to plan beforehand what the researcher is going to meet during his research path. Because of this interactive way of performing the study, the researcher is more inclined to consider his research as a journey, rather than with one fixed methodology (Fussel, 1995; Beghnin and Dujardin, 1988; Richmond et al., 1987; Conway et al., 1987; Morse, 1994). That might hamper scientific verification of data or results. Therefore, we had to make our journey plan explicit as well as our role during the process (Conway et al., 1987; Mettrick, 1993; Campbell, 1994, Röling, 1994a). As a result, this chapter is going to end with a detailed description of the research journey intended.

Figure 5. *Levels of aggregation of the Blackbird problem*



3.1. Research process as a journey

Our research had to be performed under one main condition: participatory approaches should lead the process (Farrington, 1988; Tobisson, 1993; Chambers, 1985), as farmers are only interested in manageable solutions, not in scientific analysis of the problem.

According to Salomon and Engel (1997), problem solving runs through four distinctive phases: conceptualization of the problem acceptable for all stakeholders concerned (phase I), articulation of the problem in relation to its causes ((phase II), identification of the solutions (phase III) and implementation of proposed solutions (phase IV). All phases might affect each other's results, which raises repetitive cycles of designing and redesigning possible solutions.

3.2. Researcher's role in the project

Due to the participatory nature of the project, team members and researchers were equally involved in the project. Also, other participants (farmers, rural workers, and extensionists) participated at equal levels. In my role as project leader and researcher, I had different roles: Sometimes as researcher, sometimes as coordinator, but most of the time as both.

As coordinator, I was fully responsible for the elaboration of a concrete project proposal complete with objectives, methodology and budget. At the same time, I had to keep the project on its track.

Being a coordinator and researcher at the same time had positive and negative aspects. The positive one was that there was full participation in any moment and place of the project. Negative ones consisted of inner conflicts between what was done and what should be done. In reality, the application of idealistic issues such as sustainability or system-oriented thinking, was difficult.

What follows is a description of the structure of our research journey in detail.

3.3. The phases of the research journey

For solving the Blackbird problem, we designed our own research process. It was adapted mainly based on Conway (1985), Conway et al. (1987), Harrington et al. (1989), Tripp and Woolley (1989), and Woolley and Tripp (1994). However, RAAKS methodology (Engel et al., 1995) can be considered to be the backbone of our methodology.

Figure 7 presents our research pathway [it has four distinctive phases]. Phase I is composed of two smaller subphases. During a workshop (first subphase) all stakeholders concerned met each other, in order to define the problem and objectives for a design of the solution concerning the Blackbird problem. Stakeholders also had to agree upon a working plan, field of study and actors to be involved. This first subphase had to result into a basis for further examination of the problem. The second subphase concerned an informal survey resulting a clear description of the Blackbird problem. During this subphase in-depth interviews, validated by available literature and field observations was done. This resulted in a number of prioritized general and specific objectives to be investigated. Also detailed insights concerning agricultural knowledge within information systems of the study areas involved, appeared to be important.

Phase II had to make stakeholders aware about causes in relation to the Blackbird problem. Also, it can be considered as the integration between experiential and experimental knowledge.

Phase III concerns the design, discussion and adjustments of a theoretical management program. It is based on the integration of knowledge gathered during Phases I and II.

Finally, Phase IV concerns the aspects related to policy development, operational aspects and commitments from the stakeholders to follow-up the management program proposal.

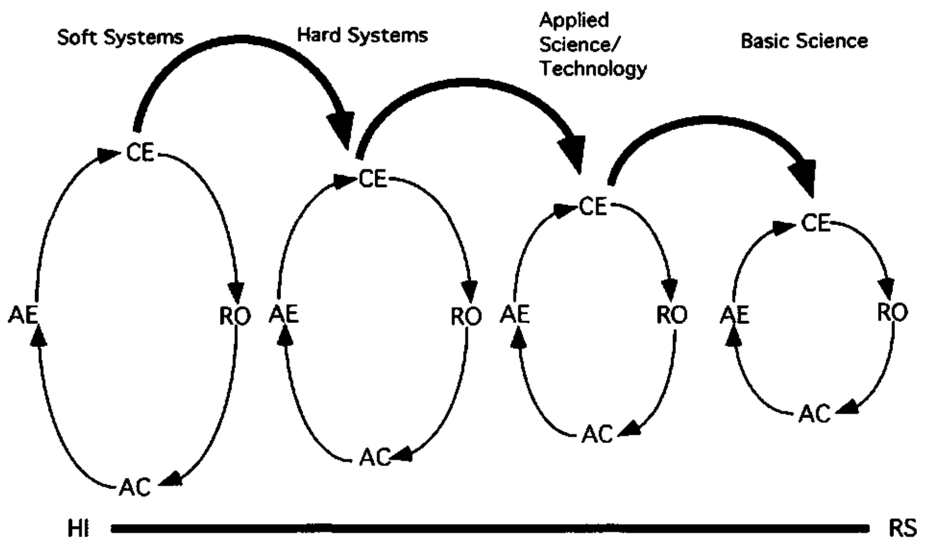
In a broad sense, the outcome [applied in the Blackbird project] was an approach to research with some characteristics (Box 3) and based on a series of steps (Figure 7) beginning with the first contact with the problems and ending with the implementation of our solution. In each step a large amount of data were collected.

Box 3. *Research characteristics in the Blackbird project*

- ✓ Identification of homogeneous groups of clients in relevant agroecological zones or socio-economic characteristics.
- ✓ A continuous and interactive research process — a dynamic "learning by doing" approach.
- ✓ An interdisciplinary approach involving natural and social scientists.
- ✓ Integration of the experiential and experimental knowledge.

Finally, in order to complete all the phases we had to learn when to focus and when to view things in their entirety — depending on the kind of problem or situation we faced. According to Wilson and Morren (1990), members of the Hawkesbury Agriculture College in Australia have visualized the connection between learning styles, the type of methodology used, and the dimension of reductionism and holism on the kind of problem we face. Figure 6 is a spiral that shows the major phases of each of the inquiry processes and the kinds of learning–style competencies that are needed in each phase. It also gives you a picture of how the reductionism-holism issue is currently seen, what methodology help us reduce problems, and which are more useful in helping us retain a picture of the wider context within which themes of concern are expressed. The figure shows that functional and structuring process is retrievable. It is like a spiraled sequence of learning moments. Each of such moments integrated data by discussion and participation. Reductionism versus holistic approaches, analysis versus synthesis, experimental hard science versus popularized knowledge were applied and integrated as complementary approaches.

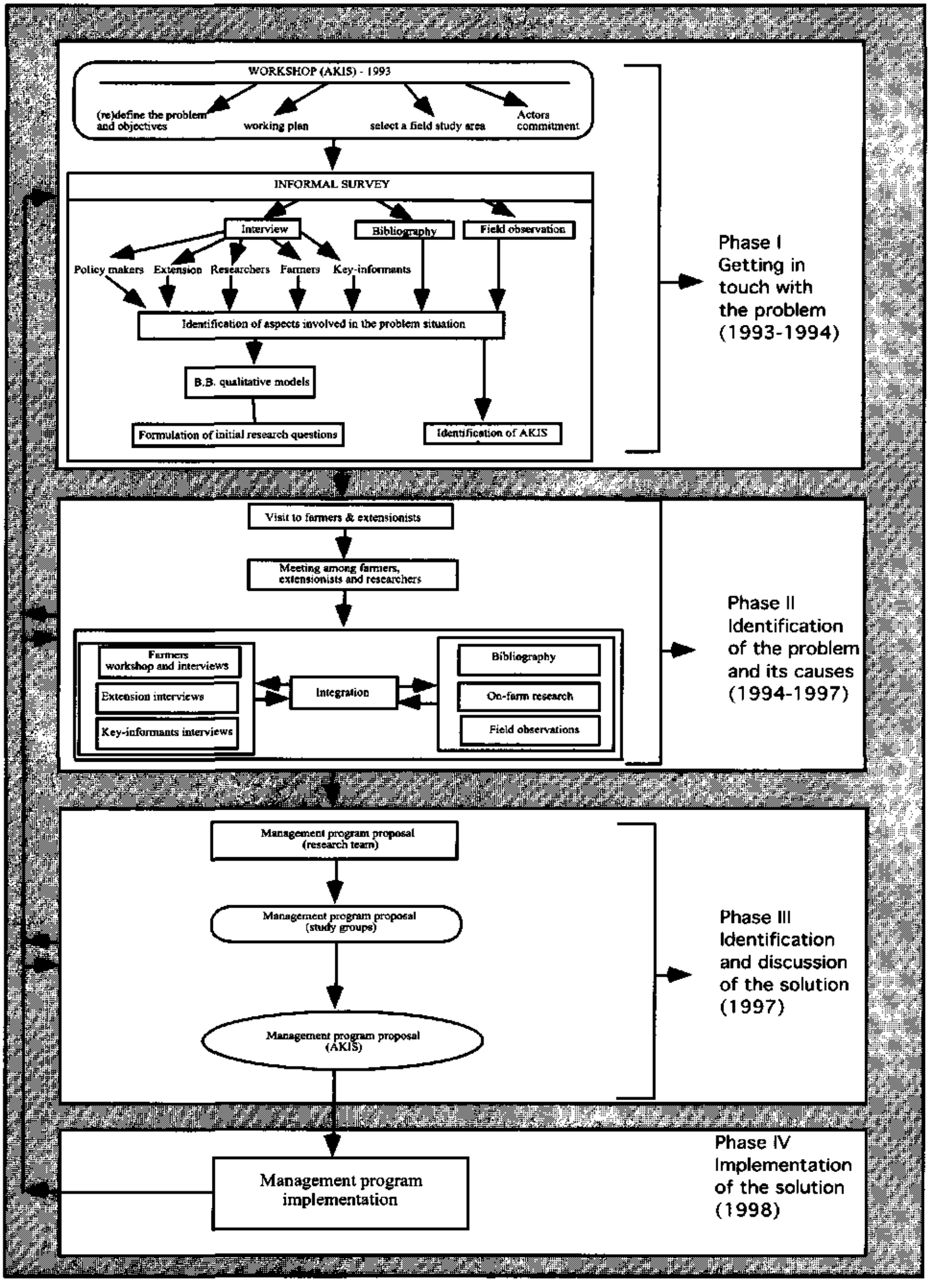
Figure 6. *The holistic integration(HI) -reductionist separation (RS) axis: a spiral of interconnected learning cycles (Wilson and Morren, 1990). Circles becomes smaller in diameter to represent the idea of reductionism.*



Learning process: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE).

Figure 7 is a schematic presentation of the research pathway, showing the linkages between the four phases. Each phase will be dealt with as an experiment in its own right in the chapter that follow.

Figure 7. *Schematic presentation of the research pathway*

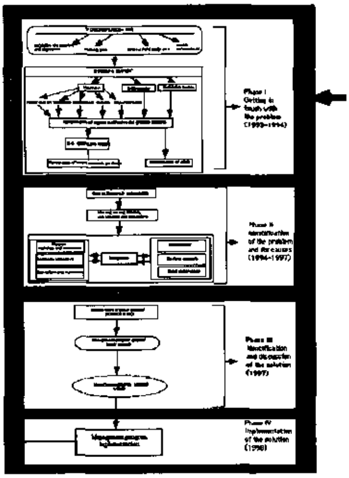


4. GETTING IN TOUCH WITH THE PROBLEM

4.1. In search of the Agricultural Knowledge and Information Systems for the Blackbird problem: Workshop and review of current knowledge

4.2. Getting in touch with the problem perceived by stakeholders (first step: an informal survey)

4.3. Identification of aspects involved in the problem situation



This chapter presents a concept of the Blackbird problem as perceived by stakeholders concerned. We got the concept in two sub-phases. Both will be presented separately.

4.1. In search of the Agricultural Knowledge and Information Systems for the Blackbird problem: Workshop and review of current knowledge

Due to the Rice Farmers Association request to solve the Blackbird problem, a project was initiated in the Agriculture Research Centre for the Temperate Climate Region (CPACT).

As a first step, in September 1993 I coordinated a Workshop in Pelotas city to promote an initial discussion about the Blackbird problem. The workshop had to reveal the Agricultural Knowledge Information Systems (AKIS) relevant for solving this problem in Rio Grande do Sul.

People were invited to the workshop by means of formal invitations to members of institutions and associations, poster distributed throughout the region, local media and personal contact with stakeholders. Taking into consideration the number and diversity of actors present (Box 4) we concluded that our invitation strategy was a success.

Box 4. *Number of Actors from different sectors and organizations identified during the workshop about the Blackbird. Pelotas, September 1993.*

- Actors
  - ✓ Rice farmers (16);
  - ✓ extensionists (13);
  - ✓ researchers (14);
  - ✓ policy-makers (8); and
  - ✓ students (10).
- Organizations.
  - ✓ University of Rio Grande (FURG)
  - ✓ University of Vale do rio dos Sinos
  - ✓ Catholic University of Pelotas (UCPel)
  - ✓ Federal University of Pelotas
  - ✓ Rio Grande do Sul State Institute for the Environment
  - ✓ Brazilian Institute for the Environment
  - ✓ Rio Grande do Sul State Institute for Agriculture Research
  - ✓ Rio Grande do Sul Rice Institute
  - ✓ Agriculture Research Centre for the Temperate Climate Region (CPACT)
  - ✓ Enterprise for Technical Assistance and Rural Extension
  - ✓ Regional Development Secretariat
  - ✓ Rice farmer's association

The workshop agenda below was defined by a committee of representative institutions (CPACT, UCPel, FURG and Rice farmer's association):

- ✓ (Re) define the problem and objectives of the study;
- ✓ Select a field study area;
- ✓ Define a working plan; and
- ✓ Obtain actors commitment

The workshop was organized to have three successive sections. It began with an introduction by a representative of the Agriculture Research Centre for the Temperate Climate Region (CPACT) about the purpose and dynamic of the workshop. Following this, a presentation of short communications related to the Blackbird problem situation took place. The first one by a representative of the Rice farmers' Association justifying the request for Blackbird control. The second one took place by a representative of the Brazilian Institute for the Environment (IBAMA) about the Brazilian legislation concerning bird control. The third one took place by a representative of the Catholic University of Pelotas (UCPel) about bird bio-ecology and control. The workshop ended with an open discussion and conceptualization of the problem and possible solutions. Results are presented according to the successive points of the workshop agenda.

4.1.1. (Re) define the problem and objective

A term of reference for the diagnosis is usually given but it often reflects the views of just some of the actors relevant to a particular innovation process. It is important to identify different views of the different actors in order to generate a 'rich picture,' disclosing relevant diversity, rather than seeking a consensus (Engel et al. 1995).

Often in workshops, some participants dominate the discussion. Empowering people to share knowledge and information is an elementary component of a participatory exercise. A Metaplan exercise was used in order to identify the problems and actions that should take place in order to deal with the problem. Metaplan is a tool developed in Germany. It stimulates discussion, and is democratic in the sense that every participant can contribute with his or her ideas to the discussion in a reasonably discrete manner. Metaplan gives those who prefer not to speak in the group for whatever reason, at least the opportunity to make their point on a card. A lively involvement of participants in the Metaplan is practically ensured, since the authors of the cards will be keen to follow its place in the organization or ranking. The ranking of the problems is done by finding a majority or consensus in the group. The moderator has to involve all the participants in the discussion and helps with the final organization of the cards (Gonzalez et al, 1995)

It became clear during the exercise, that we were dealing with conflicting objectives among some relevant actors but that it was necessary to address this. Farmers perceived the Blackbird as a pest that should be controlled, whereas environmentalists wanted to be convinced that the Blackbird is a pest and that the measures to control the Blackbird would not cause damage to environment. As already mentioned, at that time poisoned baits were the main option suggested by farmers to control Blackbirds. After discussion and negotiation a commitment among participants was reached. They should plan, execute and provide resources necessary to carry out a research project. Finally, they should elaborate and implement a concrete management program (showed Blackbird control be necessary). So, the initial request of the farmers was modified and a new request was presented and approved.

The objectives of this new request indicate main action lines, what kind of result was expected, how it should be obtained, and how solutions should be implemented. As one can see, it is quite different if compared with traditional research, where objectives are presented as precise goals, purposes, outputs and inputs (Schubert et al., 1991; Shields, 1993; United States Agency for International Development, 1980).

The final objective was to develop, through the participation of all actors, a management program to reduce or prevent damage by the Blackbird to the rice crop in the Southern Rio Grande do Sul, Brazil. The program was to take into consideration the farmers' motivations, limitations and strategies, and the regional sensitivity concerning environment protection. In order to reach the final objective, intermediate objectives, connected with the different levels of the problem perception, were defined. They are presented below.

Crop level - Identification and quantification of the damage

Chapter 1 identified the lack of official information related to the economic damage caused by the Blackbird to the rice crop. This lack of information was considered as one of the main reasons for the conflicting perceptions between farmers and environmentalists on the necessity of controlling the Blackbird. According to environmentalists, it was necessary to prove that the Blackbird is a pest affecting rice production.

To overcome the dispute research should be carried to find out if this bird was causing economic damage to the rice crop or not. To find out if there was economic damage research should not only identify but also quantify rice damage caused by the Blackbird.

Field level- Identification of the causes of the problem

Chapter 2 put forward the hypothesis that the pest problem is just one of numerous manifestations of an unbalanced environment. In addition, I demonstrated that the research carried out with other species of Blackbirds in U.S.A. did not examine the causes of the birds' population growth.

I presume that the rise in the Blackbird population had an man-made origin. Therefore, the identification of those factors could direct the choice of procedures to reduce the Blackbird population to a level that did not jeopardize the rice production and did not result in environmental impacts.

However, the identification of such factors (involving the environmental unbalance) has proved not to be an easy task. In order to identify such factors I decided to follow the suggestions of Fussel (1995) and Beghin et al. (1988). According to these authors, it is possible to exploit the causes of the problem and identify a creative and appropriate course of action through the organization of a causal-diagram[5].

Thus, a certain number of variables that presumably had roles as causal factors were selected and studied. Consequently, a causal-diagram (see Chapter 5) was built to assess the causes of growth in the Blackbird population and to identify appropriate actions to solve the problem.

4.1.2. Select a field study area

Research generates little success for farmers if technologies concerned are not adapted to agro-ecological characteristics (Mettrick 1993). That holds true for technologies designed under perfectly conditioned field experiments or laboratory-oriented research (Mettrick, 1993:46). Anderson and Lockeretz (1991), suggest that to overcome this difficulty (research adaptation to agroecological characteristics) fieldwork concerning pest control should be done on farmer's fields and in cooperation with farmers. Therefore, in search for representative experimental locations, we decided to do on-farm research. That raised sufficient opportunities for reliable experiments together with realistic circumstances, relevant for acceptance of results by farmers.

During the workshop, Rio Grande County was chosen by the majority of stakeholders as their study area. The reasons that led the actors' decisions concerning study are choice are as follows:

Rio Grande is an "homogeneous agroecological zone";

According to IBGE (1986), the coastal strip of land between the Mirim Lagoon and the Atlantic Ocean is an homogeneous agro-ecological zone. Its topography is flat and vegetation is quite uniform: rice crop, native and planted forest, salt marshes, swamps and natural pasture. Those characteristics (homogeneous agro-ecological zone) provided ideal conditions to test our research methodology in which holistic approaches, according to Mettrick (1993), are important features.

Rio Grande is a peninsula, surrounded by physical barriers;

According to Brugger and Dolbeer (1990), local birds are responsible for most of the rice crop damage in Louisiana - U.S.A. There is information that, like most birds, Blackbirds are capable of flying long distance (Dolbeer, 1978 cited by Gavin et al., 1991). Concerned about the bias that could result from the bird movement processes with regard to the project conclusions, precautions in order to reduce this bias should be taken, as much as possible, especially during the experimental phase.

The geographical location of the coastal strip of land between the Mirim lagoon and the Atlantic Ocean (Map 1) gives the area a status of an "outdoor laboratory". Its isolation could reduce the Blackbird movement with other habitats, and consequently, at least theoretically, the bias caused by this process on the project conclusions. This isolation can be justified by the following factors:

---

[5] A causal diagram is a set of organized and hierarchical causal chains linking together the factors that play, or are supposed to play, a role in a particular situation (Beghin et al, 1988).

a. The brackish environment of Rio Grande could enforce a selective regime that could reduce successful movement of Blackbirds. Gavin et al. (1991) and Basham and Mewaldt (1987, cited by Gavin et al., 1991), found a significant difference in the salt tolerance between two subspecies of Song Sparrows (*Melospiza melodia*) in the San Francisco Bay. This probable physiological adaptation could be responsible for a reduction in the interchange among populations living in upland or freshwater environments.

b. Isolation-by-distance, and islands are classic genetic models used to describe both mechanisms of gene flow and the resulting structure among conspecific populations (Rockweel and Barrowclough, 1987 cited by Gavin et al., 1991). The research area is isolated from the continent by the Mirim Lagoon and therefore could support an island model as defined by Rockwell and Barrowclough.

The research area has quite an homogeneous group of farmers (socio-economically and technologically);

When asked who his clients are, an agricultural researcher will almost certainly reply "the farmers". Ask him which farmers and the reply is a little more difficult to predict, but there is a good chance that it will be "all of them". This answer, of course, assumes that technologies are scale-neutral and equally appropriate for all sizes and kinds of farms (Mettrick, 1993:17).

Even today, many projects are doomed to failure because of the poor understanding of local conditions and forms of agricultural development that local farmers have already put into practice. Clearly, ecological conditions are not the only factors that researchers have to take into account when choosing their methods. Economic and social considerations are also very important in their decision-making. According to Lightfoot and Barker (1988), a major limitation in on-farm trials is the high variability among farmers.

According to Okali et al. (1994), there is a necessity to identify groups of farmers and consider their dynamics to properly run a project. Johnson & Johnson (1994) define a group as two or more individuals who: (a) interact with each other, (b) are interdependent, (c) define themselves and are defined by others as belonging to the group, (d) share norms concerning matters of common interest and participate in a system of interlocking roles, (e) influence each other, (f) find the group rewarding, and (g) pursue common goals.

It was clear to me that the identification of a homogeneous group could help the development of the research phase and especially the implementation of the Blackbird management program. So, taking into consideration the different rice production areas (Map 1) in Rio Grande do Sul State, the natural ecosystem division done by EMBRAPA-CPACT (1993), their social organization (FARSUL, FEDERARROZ and CITEs), its economic and technical characteristics (Zaffaroni et al., 1996; Zaffaroni et al., 1997), and that rice is the prevailing production crop in the region (IRGA/NATE, 1993; ITEPA, 1997), the rice farmers in Rio Grande county where considered as a homogeneous group.

Farmers have a common problem - the Blackbird;

It is mentioned in the previous paragraph that a group is identified, among other factors, by the existence of a common goal. The necessity of a solution for a common problem can be considered as a common goal.

According to Johnson & Johnson (1994), a group with a common goal functions more effectively. The members of a group are more loyal to the group and more willing to work towards a common goal. Members of cohesive groups take on group responsibilities more often, persist longer in working toward difficult goals, and are more motivated to accomplish the group tasks.

Therefore, it was strategic to search for a region that possessed a group whose common and important problem was the Blackbird. It would facilitate not only the necessary partnership with the farmers for the research phase, but also the accomplishment of a future management plan.

It became clear during the workshop that the Blackbird was a common problem for the rice farmers in Rio Grande County.

Farmers and researchers accepted to work together to solve the problem;

The farmers' participatory activity in research is probably the most vigorous area of development at present. They are involved in the definition of the research agenda, the process of research, the evaluation of results and the distribution of the findings (Mettrick, 1993).

There is a greater chance that technologies that arise from the integration of the experience and insights of the farmers with the knowledge and experimental rigor of the scientists will be more suitable for the farmer's situation. After all, farmers will only adopt those technologies that they see as suitable. Farmers are much more likely to be responsive to the ideas of researchers if their views are respected and differences are reconciled through debate (Mettrick, 1993).

Since the beginning of the project activities, and even before the workshop to discuss the Blackbird problem, the rice farmers expressed their willingness to participate in all the processes, and researchers to validate the farmers' knowledge. According to Lightfoot and Barker (1988), this mutual commitment is fundamental for the smooth accomplishment of on-farm research. It ensured that the project would be carried out with actions and decisions taken, simultaneously, by a group composed of researchers and farmers.

Inhabitants are aware about ecological issues;

By observing the announcements of chiefs of state (The World Commission of Environment and Development, 1987), one can conclude that sustainability is nowadays an important criterion in policy-making [at all levels].

In a broad classification, decision to adopt practices of sustainable agriculture is based on religious or philosophical principles, on necessity of decreasing production costs, on demand for organic products, and on a search for a stable environment – categories which are not incompatible (Cunha, 1997; Guivant, 1994; Committee on the role of alternative farming methods in modern production agriculture, 1989).

Some indicators of the sensibility of Rio Grande do Sul (State) population to the environmental issue are as follows. They reinforce the possibility of an easier research and accomplishment of a sustainable solution to the Blackbird problem.

The rice farmers consider farming a way of life and not just an enterprise. In 1989 the annual inflation in Brazil reached 1.764,86 % (Brum, 1995). At that time, leave the money in the bank was more profitable than farming. Even under this situation the rice farmers never decreased the acreage of their crops (see also Figure 1). During the period that I worked with them, I used to ask why they did not alter their strategy. Their answer was always the same: "We are farmers. Farming is what we know and what we like to do".

The National Park of Taim, with 30.000 ha (Map 1), is located in Rio Grande county. Research and educational activities are conducted in this area, aimed at preservation and protection as well as the development of actions toward the reproduction of some species threatened with extinction.

Rio Grande do Sul is the only state of Brazil where a hunting legislation exists. This legislation is a result of an agreement among hunting organizations — mainly from Southern Rio Grande do Sul — and the government. One of the objectives of this legislation was to protect some species from extinction by means of intense surveillance. It has been cited several times as an example of cooperation for the Conservation of Nature.

Rio Grande do Sul is the first Brazilian state to discuss and implement the necessity of agronomic prescription for use and commercialization of pesticides (1976). Due to this legislation several products, like DDT, ALDRIN and others have been banned.

Finally, *Rio Grande county is characterized by low soil fertility* (Cunha, et al., 1996) *with high risk of degradation* (Scott and Carbonell, 1986). Even presetting unfavorable conditions concerning soil fertility and risk of degradation, it is possible to find a mean rice productivity of 4,3 t ton per hectare (ITEPA, 1997). Partly this productivity is due to soil conservation practices adopted in the region (Gomes et al., 1996). This high production (under unfavorable conditions) and the fact that only 5,63% of the rice-cultivated area receives applications of insecticides (Anuário estatístico do arroz, 1988) can explain why rice farmers are recognized nationally as environmentally responsible.

Easy road access from Pelotas and Rio Grande cities.

The project's research area belongs to the county of Rio Grande (Map 1). The distance from Pelotas or Rio Grande cities is approximately 100 Km, which is not considered a great distance in Brazilians terms. There are satisfactory road conditions and the research institutions engaged with the Blackbird project are located in both cities. Therefore, this experimental area, exactly between the two towns, is strategically located, facilitating movement of the team to the study area.

It is important to mention that the "accessibility" was decisive in choosing between the two potential experimental areas: a) The coastal strip of land between the Atlantic Ocean and the Mirim Lagoon, and b) the coastal strip of land between the Atlantic Ocean and the Patos Lagoon (Map 1). The latter exhibited more advantages from the "island" aspect, but was rejected after taking into account the road conditions in the area. There are no asphalt roads in the region and in wintertime, driving becomes problematic — resulting in greater difficulties during the required regular visits to the experimental area.

4.1.3. Define a working plan

It is normal to find blanket recommendations that have failed because they did not take into account the diversity of farmer circumstances (Mettrick, 1993).

During workshops, most participants showed their concerns about the role of disciplinary oriented scientific research institutions. Farmers complained about many confrontations with inappropriate farming technologies. It was also discovered during workshops that participation in technology and farm management development is necessary. Participants made it clear that the Blackbird project's success is very much dependent on a solid understanding of local conditions, traditions and experiences of farmers (Lightfoot and Barker, 1988; Merrill-Sands et al., 1991; Tripp and Woolley, 1989; Mettrick, 1993).

It was decided that relevant technologies should be developed in rice production areas, representative for most rice producing farms in Rio Grande do Sul. An adventitious side effect of such an area would be that scientific data could be gathered under quite controlled conditions. Such a production area was selected on the basis of homogeneous characteristics concerning social, economical and ecological features (see Map 1). Workshops decided to do all field research in Rio Grande State. An outline of a management plan concerning the control of Blackbirds had to be developed in the coastal zone between the Mirim Lagoon and the Atlantic Ocean in Rio Grande and Santa Vitória do Palmar counties. Further development had to be done after the introduction of the first design of the management plan in other areas of Rio Grande do Sul State. Table 6 indicates characteristics of each phase of the working plan.

Table 6. *Blackbird strategic working plan showing total land areas, areas under rice production and proportion of total rice production for each phase of the research program in Rio Grande do Sul (*IBGE, 1986; **IRGA/NATE, 1993)*

Phases of the working plan	Total area* (Km^2)	Rice production area** (Ha)	% of the rice production area*
Field research activities	3338	30 922	3
Outline of a management program	7974	125 922	14
Management program	282184	933 114	100

4.1.4. Obtain actors commitment

A complex social innovation process cannot be directed by one person alone (Engel et al., 1995). According to Johnson and Johnson (1994), stakeholders involved with solving a problem like the Blackbirds, must co-operate together fully on a voluntary basis. Vereiken (1992),.reported that a concerted action such as that needed to solve a problem on a regional level must be done by stakeholders who have expressed their willingness to co-operate together. Acording to Mettrick (1993) and Engel (1997) a scientist should function as a facilitator rather than a researcher. Also Van Eÿk (1998) and Wiskerke(1997) demonstrated how important a free open-minded process is, as opposed to a process based knowledge from project leader.

A lot of time was spent gaining the trust of farmers in the project. To achieve this, we organized meetings with stakeholders. Relevant stakeholders were farmers, suppliers, scientific research institutes and regional extension services. The farmers' opinions concerning the critical success factors for the project were sought, and discussions began easily in most cases. Our role was to find out which farmer had the most influence within the region. We also wanted to know which stakeholders suffered from the Blackbird problem the most. The quality and strength of the relationship between the victims of the Blackbird problem and "powerful" stakeholders was very important for us. Another point of interest was to know which farms had the best conditions for designing management plans.

During all discussions, we, as scientists refrained from comment or from driving discussions towards our points of interest by purpose. This was not easy. Discussions could drift miles away from the relevant facts and sometimes were of no purpose at all within the framework of this thesis. Discussions became more or less social talks about current problems in the rice sector. However, all such deviations from our main focus were seen to have had the positive effect of building confidence in us as project leaders as well as building a solid basis of agreements between participating stakeholders and the project leader.

The outcome of this discussion process was positive. Indeed, stakeholders were able to highlight the factors necessary for a successful development of a management plan concerning the control of Blackbirds. Confidence was high concerning our proposal about how to come to an effective management plan and there was full support for all the activities within the framework of the project.

The result of all the discussions led to two configurations of relevant stakeholders, that is to say, people important for finding solutions concerning Blackbird control. One configuration related to the research phase of the project and became responsible for data and fact-findings. The other configuration related to the concerted actions necessary for a development of an effective management plan for control of Black birds in rice production. Table 7 indicates the stakeholders identified for one or both configurations.

Table 7. *Configurations of relevant stakeholders on two different phases of the project.*

a. Research phase

- -Agricultural Research Centre for the Temperate Climate Region (CPACT) (coordination)
- -Catholic University of Pelotas (UCPel)
- -University of Rio Grande (FURG)
- -Granja 4 Irmãos e Granja Branqueada do Salso
- -Clubs for Integration and Exchange of Experience (CITEs 01)

b. Management program

b.1. Technical support

- -Agricultural Research Centre for the Temperate Climate Region (CPACT) (coordination)
- -Catholic University of Pelotas (UCPel)
- -University of Rio Grande (FURG)

b.2. Financial support: Assessment of resources to carry out the program and execute the recommended actions.

- -Rio Grande do Sul Rice Institute (IRGA)
- -Brazilian National Bank (Banco do Brasil)
- -Federation of Clubs for Integration and Exchange of Experience (FEDERACITE)
- -Rio Grande do Sul Rice Farmers Federation (FEDERARROZ)
- -Agricultural Research Centre for the Temperate Climate Region (CPACT) Ricewater-seed group (Grupo pré-germinado)

b.3. Information and education support: Communication strategies that enable the information to reach all rice farmers in the region.

- -Agricultural Research Centre for the Temperate Climate Region (CPACT)
- -Enterprise for Technical Assistance and Rural Extension (EMATER)
- -Rio Grande do Sul Rice Institute (IRGA)
- -Brazilian National Bank (Banco do Brasil)
- -Brazilian Institute for the Environment (IBAMA)
- -Technical offices
- -Agricultural companies

4.2. Getting in touch with the problem perceived by the stakeholders (first step: an informal survey)[6]

The informal survey, designed as above, is an essential first step in the planning of future formal surveys. Informal surveys provide us with rapid and cheap ways of understanding the systems involved in the study. The focus is on "understanding" rather than "quantifying". An umbrella term for informal surveys approaches was coined by the term Rapid Rural Appraisal (RRA) and can encompass a series of different methodologies but is now recognized as having its own characteristics (Mettrick, 1993). This informal survey helped us to get in touch with the nature of the Blackbird problem. Our goal was to find out the most relevant initial research questions to ask, in order to help us to articulate the problem. At the same time, we wanted to find out what knowledge the stakeholders already had on the basis of their everyday experiences with Blackbirds. Experiential and experimental knowledge together are essential factors in the process of problem solving (Salomon and Engel, 1997).

The informal survey started with the exploration of three main information pools: in depth interviews with stakeholders, bibliographic studies and field observations. Data, thus

---

[6] Silva, J. J. C.[1], Franco, D. F.[1], Asmus, M. L.[2], Cirne, M. P.[3], Cruz, J. A[3].
[1]EMBRAP-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS
[2]Dept° de Oceanografia – FURG, caixa postal 474, CEP 96201-900, Rio Grande – RS
[3]UCPel, caixa postal 402, CEP 96100, Pelotas - RS

obtained, were compared with data collected by field study groups. Such study groups were very much the same as the so-called CITEs groups. CITE is the acronym for *Clubes de Integração e Troca de Experiência* (Clubs for Integration and Exchange of Experience). The first club (CITEs 01) was established in 1967, in Rio Grande county. It was composed of 12 rural families. They met each other once a month, taking it in turn to host the meeting. During the meetings, presentations about technical-scientific issues were discussed. One of the main challenges for each farmer was to present better production results than the previous year. In 1976, this system was copied by the official Extension Service. There are more than one hundred clubs in Rio Grande do Sul State at present. Frequent participation of technicians at meetings has resulted in a close relationship between farmers and research and extension institutions. Today CITEs are the basis for preparing formal agreements concerning research activities. CITEs were very useful tools for some aspects of our study, but not for all. In some cases, we needed to meet farmers more frequently. That is, when new information or extra activities demanded verification or support. CITEs therefore were used for data collection and when necessary, special project-oriented meetings between researchers and farmers were arranged for deeper discussions. Such meetings had workshop characteristics and were open for non-CITEs members.

In following paragraphs we present data obtained with each of three main information pools.

4.2.1. Interviews

Interviews were done among 18 people from different social groups: farmers, extensionists, other stakeholders and policy makers, all of these being involved in rice production in the Southern region of Rio Grande do Sul. Participation in the interviews was both anonymous and voluntary. Our approach was informal following a creative interview technique cited by Fontana and Frey (1994). A pre-designed format was not regarded as necessary since what required was qualitative verbal reports on the Blackbird problem rather than hard facts and figures in relation to certain opinions. "Forgetting the rules" in creative interviewing gave us an insight into what really concerned the participants in terms of the Blackbird problem.

Our key informants were intentionally selected out of the participants of the 1993 workshop. In this way, we knew that the informants were interested in solving the problem. We focused interviews and talks on informants' vision and experiences concerning the Blackbird problem. Not all the oral reports were used for further research. The information chosen, was selected using the "appropriate imprecision" principle suggested by Chambers (1985). According to Chambers, much of the data collected especially from surveys, has a degree of accuracy that is unnecessary. Each interview commenced with minimal information from our side. We explicitly said that we were only interested in the informant's own ideas, thinking and observations concerning the problem, thus avoiding influencing the informant by our ideas. Informants were reminded that we had to learn from them and that their knowledge was essential in solving the Blackbird problem.

To prevent a possible situation where the interviewee answers a question in terms of what he or she feels the interviewer would like to hear, the interview was conducted using a type of checklist[7] rather than a questionnaire as such. This facilitated an informal but reliable interview, giving sufficient room for the exploration of complicated or interesting topics. According to Mettrick (1993), when teams have prepared a detailed list of questions to be

[7] As its name suggests, is no more than a list of reminders of topics to be discussed with farmers when one is making an informal survey. Its purpose is to suggest starting points for discussions with farmers so those major topics are not forgotten. The guiding principle is that it should allow as much flexibility as possible (Mettrick, 1993).

asked in an informal survey, it has usually resulted in a rather unsatisfactory outcome. According to the author, team members have been unable to break out of the straight jacket of the questions to enter a genuine dialogue with farmers. Because checklists are simple yet comprehensive, little can be said about the rules for designing them. A page diagram was constructed where some central key words relating to the subject were written as a type of checklist. Every time that some idea impressed me as important or interesting it was just added onto the diagram or connected to the corresponding word [on the checklist]. The advantage of this method is that the interview flows better. There is no time constraint to cover previously determined subjects. Finally, the interview report becomes easy to analyze and record.

4.2.2. Bibliography

Unfortunately, only a few publications could be found about *A. ruficapillus*. However, literature about related species may prove to be helpful. A broader historical perspective of main subjects covered by literature concerning the Blackbird problem and rice, is outlined and contains the results of a survey of scientific and other grey[8] information.

Table 5 (see Chapter 2) summarizes retrievable literature. This table reflects the sequential development of the literature beginning in 1950 and ending in 1995. The analysis of such literature presents an understanding of how researchers tackled the Blackbird problem. It suggests that researchers have been concerned with the Blackbird problem since at least 1950. However, results indicate that research concerning Blackbirds has been principally devised by researchers using conventional design and analytical procedures. The primary objective of most projects has been to tackle the problem by killing or driving away birds reducing crop damage rather than removing the cause of the Blackbird population increase (Table 8). Most importantly, this conventional approach of pest control fails to incorporate the experiential knowledge of the farmer in research design as well as identifying and implementing solutions. The result gives the impression that much of research involving the Blackbird problem is cosmetic, and without direction.

Table 8. *Frequency of main groups of subjects identified by the number of times that it appears on78 publications about Blackbirds. Most of the time, publications cover more than one subject.*

Main groups of subjects on literature	Specific subjects on literature
Destruction of birds (48)	net traps, hunting, poisoned baits, nest destruction, toxicology, costs of control
The driving away of birds(46)	explosions/fireworks, scarecrows, sound devices, repellents
Crop damage reduction (20)	timing the crop, general cultural practices, increasing seed rate, plant breeding, trap crops
Identification and quantification of damage (34)	
Natural life of Blackbird (48)	ethology, reproduction, population studies, general biology, taxonomy/description
Other birds associated with rice (8)	
The causes of the severe population increase (-)	

[8] By grey information, we mean publications not easily retrievable by search on scientific libraries. This grey information can be a report or a letter; as well, it can be an article in a newspaper or magazine.

4.2.3. Field observation

According to (Mettrick, 1993; Engel et al., 1995) information gathered from interviews and bibliographical studies always has to be validated by direct observations on the field. Stakeholders' knowledge might be influenced by ideas based on a desired situation rather than with facts. It is important to affirm that farmers really do what they say they do. Bibliographical information most commonly refers to situations that differ to the one in Southern Rio Grande do Sul. Validation was carried through on field checks and observations and this was cross checked through discussions with other informants. In addition, social events, congresses and symposia elsewhere were used for controlling our data obtained by the interview technique. Direct field observation also serves another goal by helping to reveal problems or issues not immediately obvious to the stakeholders concerned.

Field observation reinforced and qualified the results obtained from the informal survey. Twenty field trips were made during this phase. Each one lasted approximately two days in the target area. During each trip, researchers observed the natural life of the Blackbird, the damage caused by the bird in different stages of the rice crop and everything that could be relevant to understanding the situation. Furthermore, during visits to farmers we talked with their rural labourers, most of them living on the farm since they were born. The possessed wide practical experience not only related to farming aspects but related with the process of nature as well, such as climate, wild animals...and Blackbirds. During these 'field trips' certain findings related to the Blackbird caught our attention [some of them quite curious] and helped us to focus our research:

- Innumerable flocks of Blackbirds on the main road;
- A man "sweeping" a bridge to collect rice lost from trucks during transport from farm to rice mills
- Blackbirds feeding on rice "residues" (material separated from rice in the cleaning process) accumulated on waste heaps adjacent to farm rice refinery plants;
- Blackbird nests, with eggs, were found from September to May (spring to autumn), while Belton (1985) and Fallavena (1988) reported that Blackbirds in the area only laid eggs in February. Which is also what the farmers had believed; and
- The Blackbird nests on trees, on bushes, and inside buildings, while Belton (1985) and Fallavena (1988) reported that Blackbirds only build their nests in swamps and rice. Farmers also had believed this to be the case.

Our findings, after repeated confirmation by field studies, brought to light that the Blackbirds causing the problems in rice production in Rio Grande do Sul, [apparently, at the period of our observations] had changed their phenology. According to (Silva et al., 1997c) we accepted that Blackbirds of the region adapted their behavior due to the abundant amount of food all the year round. Our hypothesis was as follows. Rice found on roads, residues in waste heaps or open rice warehouses provided the Blackbirds with sufficient food outside the production season, for generating more generations than would happen under "food poor" winter seasons. Our research should therefore consider the effects on population dynamics of the Blackbird under "resource poor" winter conditions.

4.3. Identification of aspects involved in the problem situation

With the hypothesis in mind, two main considerations had to be addressed in order to design a management plan for Blackbird control. The first consideration concerns participants in the agricultural production of rice and the second, the factors involved in transport, storage and refinery of rice in between the harvest and sowing season. The population dynamics of the Black bird itself is of course, important as well. More knowledge about its' behavior in relation to rice production cycles at farm fields was needed. This conclusion is in line with Engel et al. (1995) who states that natural resource availability, agro-ecological constraints, and also socio-economic and cultural factors can influence the performance of the system.

4.3.1. Identification of AKIS (Agricultural Knowledge and Information Systems)

Within each region, farmers are surrounded by knowledge. In the first place their own, e.g. formal knowledge obtained form extensionists, but also experiential knowledge. That is knowledge which farmers have obtained over the years through working with their own farm. Other knowledge resources are those of research institutions, Extension Services, policy makers, consumers, transport organizations and even industry. All such knowledge influences aspects of agriculture in a certain area. Röling (1990) says that AKIS is the knowledge support system of each farmer. Only within such a realm can scientists obtain their understanding of certain agricultural activities. In other words: if a scientist wants to solve certain shortcomings in agriculture within a certain area, then he should analyses the problem within its real context.

Analyzing the problem through use of experiments under conditioned laboratory or experimental circumstances may give different results. Results from conditioned experiments just say something about phenomena within that realm. Such results usually loose their relevance as soon as the supposed solutions are introduced in the everyday reality of the farmers' world. Röling and Engel (1991) therefore point out the necessity of gaining knowledge from all the stakeholders around the farmer as well.

AKIS is defined as a set of agricultural organizations or people, engaged in processes of decision-making concerning agricultural problems. The organizations and people in question should have a strong interrelation concerning questions like transformation, transmission, stock and retrieval of knowledge relevant for supporting decision-making by producers, transporters, traders, industry and retailers a certain area. AKIS is a typical form of addressing production chains (Röling, 1990). The AKIS perspective recognizes that agricultural development cannot come about because of the efforts of a single group, institution or firm (Röling and Engel, 1991). No single group whether they be scientists, technicians or even farmers are responsible for innovation in agriculture. Rather, it is the interdependent and coordinated activities of a whole set of actors that stimulate or, alternatively, frustrate processes of innovation.

The blackbird problem tuned out to be a regional problem. Only concerted actions by different stakeholders could support the beginning of a solution. Therefore, AKIS was a perfect way for analyzing the problem. The following steps were undertaken.

- Identification of AKIS actors and their principal objectives.
- An examination of where the opinions of the different stakeholders converge and where they don't.
- Identification of AKIS actors and their importance for the project.
- Identification of sources and channels used by farmers to obtain information.
- Identification of actors involved in rice production and demonstrating the level of importance, from the farmer' point of view.
- Flow of technical information available in rice production

The conclusions are as follows.

Identification of opinions concerning the desired development with various stakeholders

Firstly, we identified all the relevant actors and then categorized them (Table 9). The objectives of each actor were identified during the workshops.

Table 9. *AKIS actors and their principal objectives.*

ACTORS	OBJECTIVES
GOVERNMENTAL EXTENSION AGENCIES	
EMATER	Rural and local development in the State of Rio Grande do Sul.
UFPel (extension department)	Education, research and extension (federal; mandate regional)
CPACT (TTD)	Research for regional development (federal; regional);
FEPAM	Education of natural resources in Rio Grande do Sul State;
IBAMA	Education of natural resources (federal)
IRGA	Rice farmers development (State of Rio Grande do Sul)
PRIVATE EXTENSION AGENCIES	
Agricultural companies (chemical; equipment)	Demonstration and technical assistance of products
Technical offices	Technical assistance in the entire production process
EXTREMOSUL (Rice Farmers' cooperative)	Technical assistance in the entire production process
GOVERNMENTAL RESEARCH	
CPACT	Regional development of technologies (South Brazil)
UFPel	Education and research for the region (federal; mandate regional);
FURG	Education and research for the region (federal; mandate regional);
IRGA	Research for rice farmers development (State of Rio Grande do Sul)
FZB	Research with natural resources (State of Rio Grande do Sul)
IPAGRO	Research for State development; improve technologies
PRIVATE RESEARCH	
UCPel	Education and research for the region (private; mandate regional);
UNISINOS	Education and research for the region (private; mandate regional);
Agricultural companies (chemical; equipment)	Development and adaptation of products
Granja 4 Irmãos (rural enterprise)	Development and adaptation of technologies
POLICY	
MARA	Agricultural development (federal; national mandate)
EMBRAPA - Headquarters	National Agriculture Research Policy
State Secretariat of Agriculture	State Agricultural and Rural Development Policy
FEPAM	Implementation, control and legislative body for the protection of Natural Resources (Rio Grande do Sul mandate)
IBAMA	Implementation, control and legislative body for the protection of Natural Resources (federal; regional mandate)
Banco do Brasil	Regional development (federal; regional development)
NGOs	
CITES	Exchange information among farmers (Study group), representation of the members (Local mandate)
Rice farmers associations	Development, protection and representation of the members
MARKET	
Rice Mills	Rice marketing

Actors analysis

Many institutions (governmental and non-governmental) in Rio Grande do Sul have a lot to do with farming. We found that mutual interaction among them was difficult to identify.

For example, we observed that several institutions were involved with same activities, at the same time and in the same area. Today, most problems are too complex for institutions to work at on their own. Simple scientific problems are already answered. Difficult ones, mostly those of a regional nature, remain. Institutional co-operation is essential, for problems concerning modern agriculture need quite a lot of information from various disciplines and resources. Demands are large from both a financial and an organizational point of view. Present situations in most agricultural institutions reflect scientific policies from the past. Agriculture has lost its technical, integrating profile and has become a sum of disciplines with scientific objectives. The focus is no longer to solve the problem of the farmers but to satisfy the needs of scientists to be recognized and accepted as being competent in the field (unpublished summary of a meeting among stakeholders in 1993 in CPACT).

During the strategic phase of planning, it became clear that the Blackbird project should consider the necessity to integrate the efforts among different actors. The information gathered during the meeting with stakeholders (1993), the workshop about the Blackbird (1993), and interviews carried out during the informal survey, were fundamental in order to identify areas of convergence and possibilities for resources coalitions. This information is summarized on table.10 (AKIS actors and their importance for the project).

Table 10. *AKIS actors and their importance for the project*

ACTORS	KEY-ACTOR	WHY?
EMATER	YES	Extensionists in the region working with pre-germinate technology
UFPEL	No	No priority for the Blackbird problem
CPACT	YES	Development and transference of technologies for rice farmers; financial support for the Blackbird project
FEPAM	NO	Without significant activity in the region
IBAMA	YES	Implementation, education, control and legislative body for the protection of Natural Resources (federal; regional mandate)
IRGA	YES	Development and transference of technologies for rice farmers.
Agricultural companies (chemical and equipment.)	YES	Staff in the region working with pre-germinate technology; financial support for the Blackbird project
Technical offices	YES	Technical assistance in the entire production process
EXTREMOSUL	YES	Technical assistance; financial support for the Blackbird project
FURG	YES	Research with modeling and simulation of natural resources
FZB	NO	Occasionally working with natural resources in the region
IPAGRO	NO	No priority for rice crop
UCPel	YES	Research in the region concerning biology and ecology of birds
UNISINOS	NO	No priority for rice crop
Granja 4 Irmãos (rural enterprise)	Yes	Development and adaptation of technologies; logistic* and financial support for the Blackbird project
MARA	NO	Interest in national policy
EMBRAPA headquarters	NO	Interest in national policy
Secretariat of Agriculture	NO	Interest in State policy
Banco do Brasil	YES	Financial support (campaign to inform about BB program)
SDR	NO	Regional development - not related with the problem situation
Media	YES	Strategic support (campaign to inform about BB program)
Rice mills	YES	Strategic support (campaign to inform about BB program)
GETA/CITEs	YES	Best channel to exchange information among and with farmers
Rice farmers association	YES	Logistic* and political support

* *Here logistic means: Access to the area, food, housing, telephone and information related to natural resources and farming.*

Identification of sources and channels used by farmers to obtain information

Engel et al (1995) emphasized that information streams between regional stakeholders are essential and much more important than those from scientific research institutions alone. We found that information exchange usually occurred between actors who recognized each other as leaders in their field, i.e. the most successful farmer, the best entrepreneur, or a person having the best financial results. Also actors, who are well known because they showed to be accurate readers of practical papers and media observers, are very much appreciated. Information streams appear to be like information networks in which each actor not only uses the information but also provides and directs it.

Our work identified very clear coalitions of information providers. It helped us to reveal how innovation in an area could be propelled by communicative interaction. Tables 11 and 12 show information streams clustered in relevant groups of actors.

Table 11. *Importance levels of the sources used by the farmers of the Southern region of Rio Grande do Sul to obtain information on technical aspects, market and sectorial politics related to rice production. EMBRAPA-ETB/CPACT, Pelotas 1997.*

Actors	Technical	Market	Sectorial policy
CPACT	Important		
EMATER	Important		
Rice meals		Very important	
Granja 4 Irmãos	Very important	Very important	
IRGA	Important	Very important	Very important
Colleagues	Very important	Very important	Very important
Banco do Brasil			Very important
Agricultural companies	Very important		
Private offices	Important		
Extremos Sul	Very important	Very important	
CITE	Very important	Very important	Very important
Media		Important	Very important
Farmers association			Important
IBAMA			Important

Table 12. *Channels used by farmers of the Southern region of Rio Grande do Sul to obtain information on technical aspects, market and sectorial politics related to rice production. EMBRAPA-ETB/CPACT, Pelotas 1997*

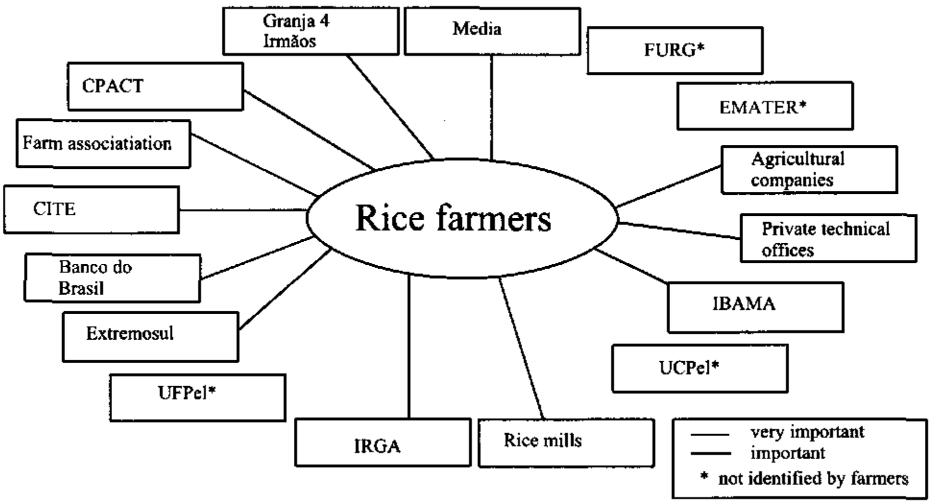
Actors	Technical	Market	Sectorial policy
Research visits	Important		
Agricultural expositions	Important		Very important
Colleagues' visit	Very important	Very important	Very important
Media		Important	Very important
Field trips	Important		
Visit by other actors	Very important	Very important	
Farmers' publications	Important		Very important
Farmers' meetings	Very important	Very important	Very important

Identification of actors involved in rice production and demonstrating the level of importance, from the farmer' point of view.

The adoption of innovative idea and process by farmers is only possible if the relationship between farmer and advisor is based on trust. Sometimes, stakeholders consider themselves, as the most knowledgeable, while their information or the analysis at which their information has been based, is not correct. Such a situation can occur for example among private extensionists involved in breeding and/or chemical companies. Their intention is to sell a product as good as possible and they rely on information obtained from their research. Within that context, their information is correct, however, within the economic context of a particular farm the information might not be true.

Discussions within workshops about the question "who is the most reliable actor here?" can be delicate. We touched that question carefully, by demonstrating where coalitions between actors have developed. We found that certain relations were more obvious and mutually recognized than others . We concluded from figure 8 who the most important actors were as seen through the eyes of the farmers involved. We considered those actors "as the most important ones". We accepted that those key-actors should become focal points for the introduction of the Blackbird management plans.

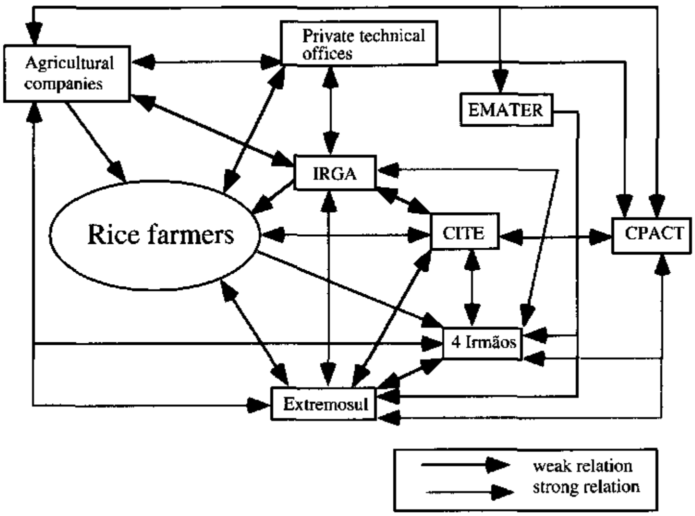
Figure 8. *Actors involved in rice production and demonstrating the levels of importance, from the farmers' point of view, in the Southern region of Rio Grande do Sul: EMBRAPA-ETB/CPACT, Pelotas1997*



Flow of technical information available in rice production

On the basis of knowledge gained, we constructed a communication network as presented in figure 9. We validated this scheme during workshops which gave us sufficient trust in the reality of the communication network around farmers. This network is most essential for the dissemination of the management plan for controlling Blackbird population densities on the rice farms.

Figure 9. *Flows of technical information available in rice production in the Southern region of Rio Grande do Sul. EMBRAPA-CPACT, Pelotas 1997*



The present AKIS analysis allowed us to identify that:

- ✓ The most important sources farmers use to obtain technical information are the agricultural companies, the 4 Irmãos, cooperative Extremo Sul, and other colleagues;
- ✓ The most important source farmers use to obtain market information are rice mills, 4 Irmãos, IRGA, other colleagues, and cooperative Extremo Sul;
- ✓ The most important source farmers use to obtain sectorial politics information are the Banco do Brasil, other colleagues, IRGA, and media;
- ✓ The most important channels that farmers use to obtain technical information are the visits made by other actors, meetings among farmers, and visits among colleagues;
- ✓ The most important channels that farmers use to obtain market information are colleagues' visits, farmers' meetings, and visit by others actors;
- ✓ The most important channels that farmers use to obtain sectorial politicy information are media, colleagues' visits, farmers' meetings, and farm publications;
- ✓ The technology produced by IRGA as well as by EMBRAPA, comes to the farmers through agricultural companies, cooperative Extremo Sul, 4 Irmãos and CITES; and
- ✓ Farmers did not identify the UFPel, neither FURG or UCPel as a technology producer to the rice crop.

Finally, from the AKIS analysis it became possible to conclude that:

- ✓ The best location for the research activities based on acceptance and dissemination of results would be on 'Fazenda 4 Irmãos';
- ✓ The information concerning the management plan of the Blackbird should use, preferably, the existing channels of information, i.e. farmers' meetings and individual visits. Along with this, agricultural fairs, the media and farmers' publications, field trips and visits to 'Fazenda 4 Irmãos' could also be used;
- ✓ Finally, agricultural companies, cooperative Extremo Sul, Granja 4 Irmãos, and CITES, together with IRGA, private technical offices and CPACT should be the main stakeholders to transfer information related to the management program. Due to its' strong relationship with rice farmers, Banco do Brasil was also identified, by farmers, as an important actor and should, therefore, be engaged in the process as well.

4.3.2. Qualitative models concerning Blackbird population development

The first step in either a regional, farm agroecosystem, crop or animal system study is the construction of a qualitative model (Hart, 1981). According to Engel et al. (1995), the creation of such a visual image, at the end of an informal survey, through diagrams, is an essential element in facilitating reflection among the team members and (representatives of) key actors. The diagram can best be thought of as an alternative effort to interpret information, opinions, and observations collected so far. Models are a comprehensive way to understanding interactions between the main components of the systems. After building a model, the team can put it forward for debate with the actors.

According to Fussel (1995), Beghin and Dujardin (1988) and Richmond et al (1987), key questions and guidelines can arise throughout the procedure of modeling. This was certainly the case in this research program. As these questions and guidelines arise, they need to be noted down and collectively revised by the participants in the light of all information available.

It was decided, since the beginning of phase I, to draw qualitative models based on data gathered during the interviews, field observation and literature review. Three models were developed: a) levels of interaction, b) conceptual; and c) causal. The purpose was to facilitate understanding of some key processes related with aspects involved in the problem.

Initially, the models were just drafts. They were informally presented and discussed with some key actors. With each subsequent discussion, the idea and analysis expressed in the model became clearer. The conclusion, reflected in a modified model prepared at the end of each successive discussion, served as starting point for the next. During the development of the project, these models were improved on as new information was obtained. Due to this dynamic process of modeling, it was decided to present them, in their final version, together with quantitative and cause-effect models, in Phase II. I believe that in Phase II readers can reach better understanding of the dynamic processes of data integration and modeling, applied within the Blackbird research project.

4.3.3. Formulation of research questions relating to the Blackbird problem

According to Checkland (1981) and Morse (1994) identification of research questions using a holistic approach as in this study, should be formulated in such a way that further study or experiments keep their regional scope. The conclusions should always address the whole picture. Conway states that identification of such questions is not simple. According to Conway et al. (1987), multidisciplinary teams are helpful in getting formulations sufficiently broad and researchable as well. During special meetings between relevant stakeholders, we reformulated our questions in repetitive cycles, until everybody had the impression that the formulation was adequate for expressing each other's vision. The result of all the discussions led to two configurations of relevant initial questions for further experimental research (Box 5). One configuration was related to the identification of the problem. The other configuration was related to the identification of causes and possible solutions for the problem.

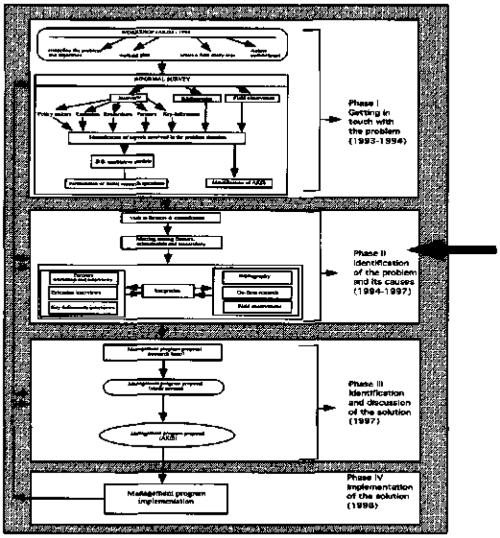
Box 5. *Initial Research questions*

- ✓ Identification of the problem
  - What kind of damage is caused by the Blackbird in rice crops?
  - How much loss is caused by the Blackbird to the rice crop?
  - Does damage differ among the various rice sowing systems?
  - Is the distance from bushes and swamps a factor in the severity of damage to rice crops?
- ✓ Identification of causes and possible solution for the problem
  - Which variables are related to the problem? What is their relative importance? How do they interrelate?
  - What can be done to solve or to reduce the problem? How could it be done?

5. IDENTIFICATION OF THE PROBLEM AND ITS CAUSES

5.1. Are Blackbirds in rice a pest?

5.2. The cause of the Blackbird population increase



In phase II, the project team detailed the conceptual model, obtained from phase I. We wanted to know about the nature of the problem and to get hard data. Then we could say more about the Blackbirds status as a pest.

As a first step on this phase, we made contact with farmers and extensionists in order to "create" a favorable environment for the second step, a meeting among researchers, farmers and extensionists to plan all field research activities that should be done. The third step, as indicated on the above diagram, was the implementation of relevant research activities.

From that point on all gathered data were presented and discussed with a group of actors (researchers, extensionists and farmers) in order to decide about the quality of data in light of our research.The splitting of the bottom of the diagram into three linked blocks represents the dynamics and structure of how knowledge was generated in this phase. The left side focuses on experiential knowledge (Anderson and Lockeretz, 1991; Mettrick, 1993; Chambers, 1992). The right side in the above diagram focuses on experimental knowledge (Farrington and Martin, 1988). We did not choose for one or the other way of knowledge raising. We applied both kinds of knowledge as they came. The center of the diagram integrates experiential and experimental knowledge. Insights obtained after integration provided the foundations for planning of further research and future farm management.

This research study demonstrates the power of participatory action and systems perspective in initiating and fostering changes with a focus on sustainability. Results of our research were well accepted by all actors and recommendations were immediately implemented. Therefore, one can safely conclude that our approach was successful.

As no sufficient literature concerning *A. ruficapillus* was available, and literature about related species provided minimal guidelines, we had to drop back on experiences from farmers. Our approach led finally to detailed experiment. Interestingly, experimental data helped to validate farmers' knowledge. Data collection was not done in a compartmentalized way. It did not occur successively one action after other, either. On the contrary, we carried out all research activities simultaneously and in a complementary fashion. This chapter present answers to two questions. Are Blackbirds really pests in rice? and, Is it possible to explain the causes of population increase of Blackbirds in Rio Grande do Sul?

5.1. Are Blackbirds in rice a pest?

The two main questions involved are: would it be possible demonstrate experimentally the damage caused to rice production by Blackbirds? And what is the relationship between the avifauna and the irrigated rice crop?

5.1.1. Identification and quantification of the damage caused by A. ruficapillus in Southern Rio Grande do Sul rice crop[9].

A cause-effect model (Diagram 1) was built for the identification and quantification of the damage caused by *A. ruficapillus* in Brazilian rice cropping. Apart from field experiments, data were obtained by interviews and workshops with people connected to rice production in the regions of Rio Grande and Santa Vitória do Palmar counties

Blackbirds eat the rice seeds and pull out the sprouts during the sowing period. In attacking the sprouts the birds usually drill a small conical hole down to the germinated kernel, which they eat, leaving the tender sprout exposed to withering by sun and air. Two crop attack patterns by this bird have been identified: At first. The first attack pattern is the most intense and occurs in crops located up to 200m from woods and marshes. Here a "to and fro" movement of the birds can be found. Birds fly constantly and in a synchronized way, from the trees or marshes to the crops. Damage is characterized by a drastic reduction in the crop "stand", requiring, in most cases re-sowing. The second attack pattern is less intense in crops located away from woods and marshes. When this occurs the flock acts as a "steamroller ", where the birds located behind the flock fly continuously to the front, over the ones on the ground. The attack occurs randomly on the entire crop, causing a reduction in the "stand", in patches, re-sowing being in most cases unnecessary.

Field experiments (Figure 10) were set up using parcels protected by cages and paired with an unprotected check (each one measuring 0,77 m^2) to access the damage caused by Blackbirds. The experiment design made it possible to analyze the difference in intensity of bird attack when rice plots (2 ha) are located close to or away from woods, and the difference of bird attack among different sowing systems. In order to analyze the difference in intensity of attack close to and away from the woods, a water-seed system was located at 50 m and 1500 m from the woods. To analyze the difference among different sowing systems we took into account information given by farmers and confirmed by in-loco observations that high intensity of attacks occurs up to 200m from the woods. Therefore, we located all the different systems more than 200 m from the woods. The results indicated a 57,9% mean reduction of rice "stand" [as patches] in areas located 50m from the woods (Photo 3) and a 24.4% mean reduction in more distant areas. No differences were detected in the intensity of the attacks among the water-seed, Conventional, No-tillage and Mix (water-seed + No-tillage) systems located away from the woods.

Using information supplied by farmers (Table 13), based on the 1996/97 crop, it has been estimated that for re-sowing approximately US$ 116.00, US$ 171.00 and US$ 181.00 are spent by hectare in the water-seed, no-tillage and conventional cultivation systems, respectively.

---

[9] Silva, J. J. C.[1]; Cirne, M.P.[2]; Franco, D. F.[1]; Asmus, M. L.[3]; Zonta, E. P.[4]& Vieira, M.M.[2]

[1] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

[2] UCPel, caixa postal 402, CEP 96100, Pelotas-RS, Brazil

[3] Deptº de Oceanografia - FURG, caixa postal 474, CEP 96201-900, Rio Grande-RS, Brazil

[4]. Instituto de Física e Matemática - UFPel, CEP 96010-900, Pelotas-RS, Brazil

Note. This experiment is part of the project 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research centre for the temperate climate region, Brazil).

Table 13. *Component items of the expenses (US$) incurring from the indirect damage caused by A. ruficapillus, when re-sowing is necessary. EMBRAPA-ETB/CPACT, Pelotas, 1997.*

Items	no-tillage	conventional	water-seed
equipment	30,00	60,00	-
herbicides	50,00	30,00	-
seeds	76,00	76,00	76,00
water	-	-	10,00
airplane (*herb. **herb. + sowing)	15,00*	15,00*	30,00**
Total	171,00	181,00	116,00

Finally — despite the fact that these figures haven't been quantified — it was identified that: a) by not re-sowing, when the attack of the blackbird is less intense, there is a reduction of productivity due to infestation of invading plants and attacks by wild ducks; and b) by re-sowing there are large losses at harvest and processing (cleaning and drying) due to the occurrence of plants in different stages of development of the crop.

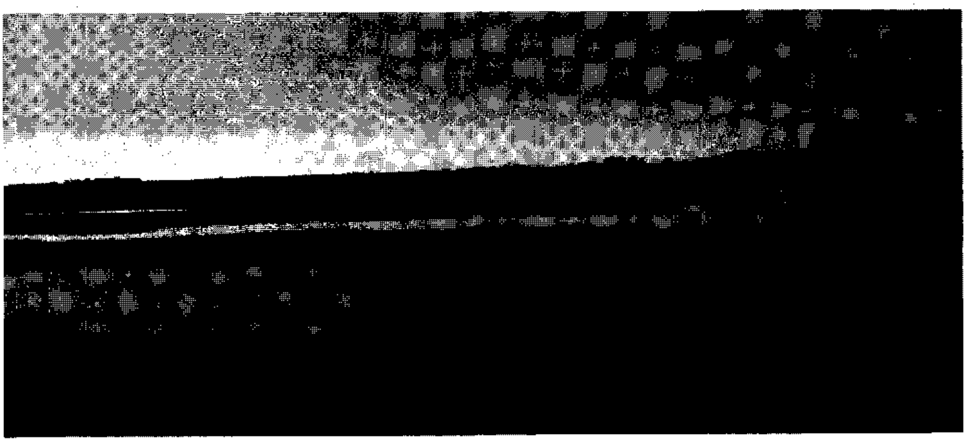


Photo 3. Damage caused by *A. ruficapillus* during the rice sowing period (Rio Grande county, Brazil, 1995).

During the phase of rice reproduction [from flowering to maturation], field experiments (Figure 11) were set up using parcels protected by cages and paired with unprotected check (each one measuring 0,77 m^2) to acess the damage caused by Blackbirds. The birds were found to suck the milky grains, and eat the doughy grains (Photo 4), apart from breaking the plants' stem and causing degraining by standing on them. The attack patterns of birds when close and away from woods is the same as the one identified during sowing. The results indicated an average reduction in the rice production of 1249 kg/ha (26.4%) in the rice plot located 50m from woods and of 964 kg/ha (22.3%) in the rice plots located 1000m from woods. Considering the value of US$ 11.00/50 kg sac, the reduction in production represent respectively losses of US$ 274.78 and US$ 212.08 per hectare. However, the statistical analysis did not detect significant differences between the two distances (Figure13). Considering the direct (US$ 274.78) and indirect (US$ 181,00) damage caused by the blackbird to the rice crop, the economic losses could reach US$ 455.78/ha.

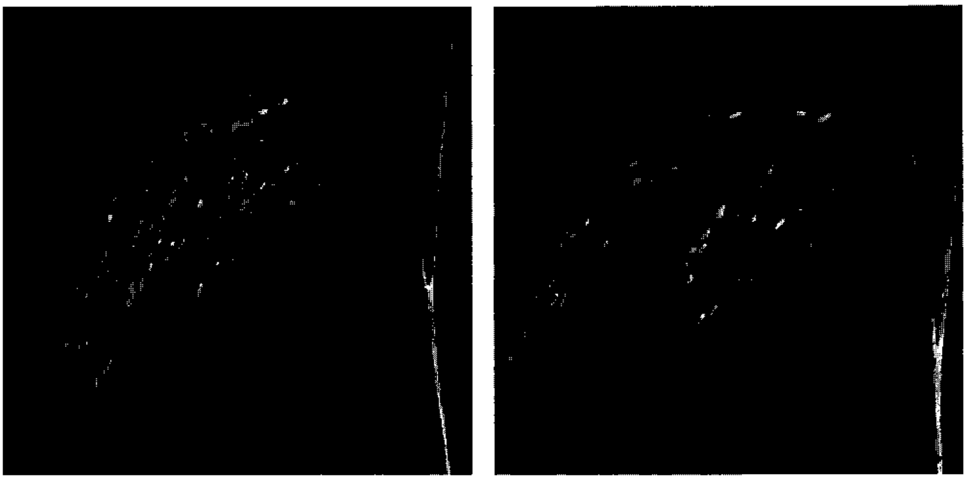


Photo 4. Damage caused by *A. ruficapillus* during the rice maturation period. Left: panicle without damage, right: panicle with damage (Rio Grande county, Brazil, 1996).

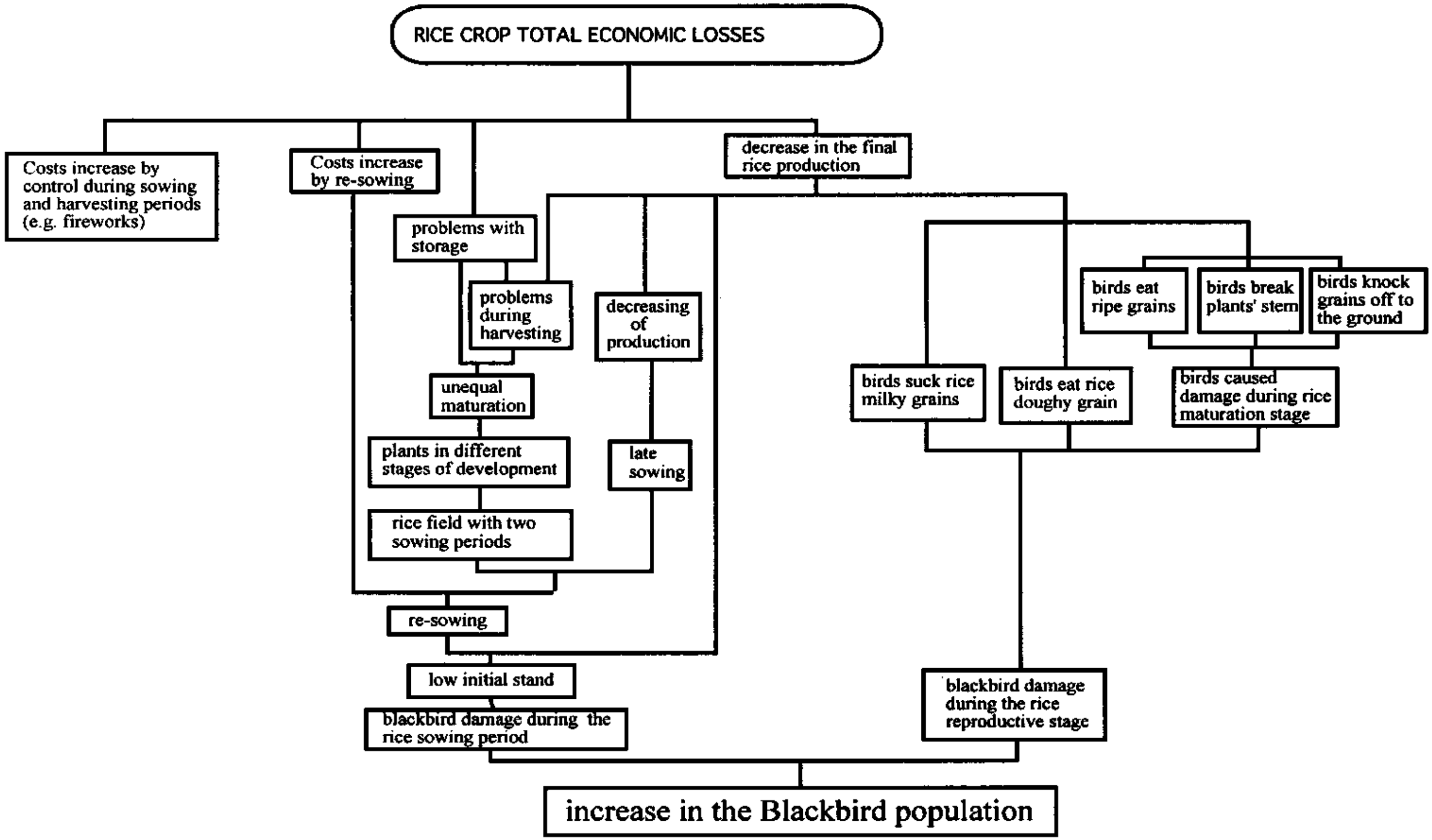
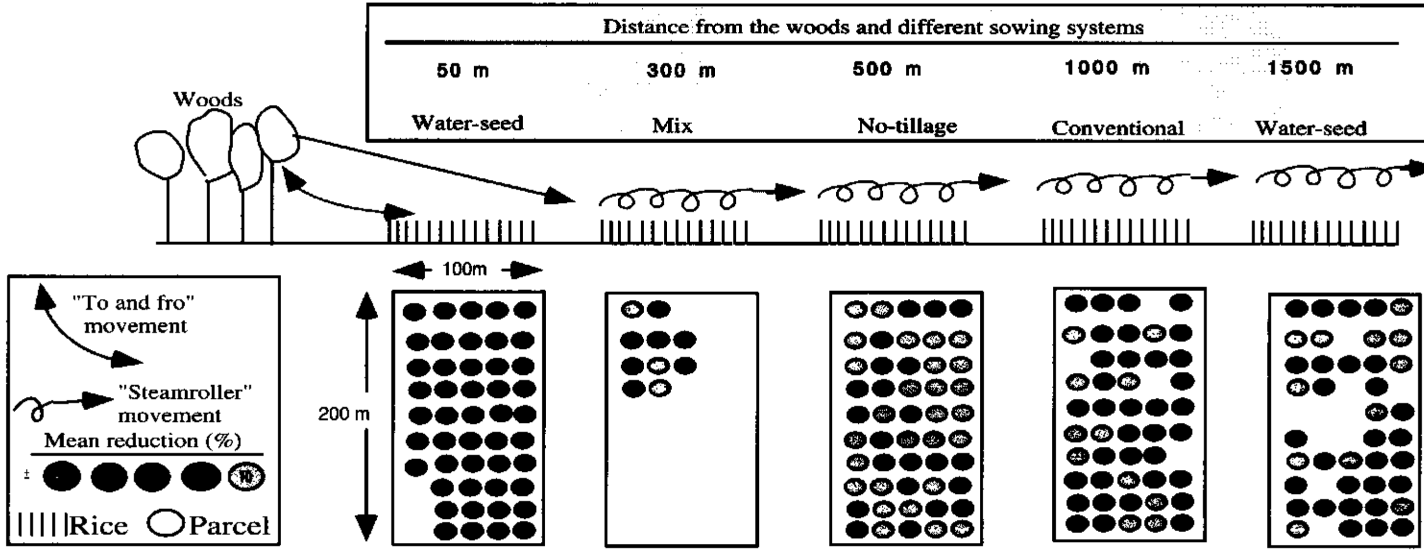


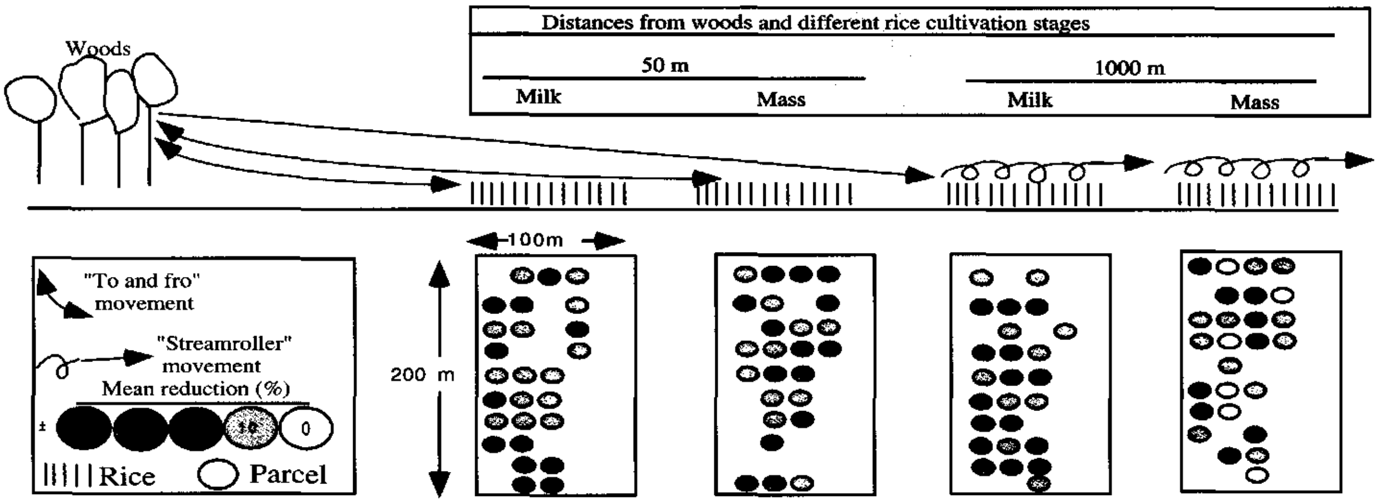
Diagram 1. *Cause-effect model of the total losses caused by A. ruficapillus in rice in the Southern area of Rio Grande do Sul, Brazil — EMBRAPA-ETB/CPACT, Pelotas, 1997.*

Figure 10. *Average reduction caused by A. ruficapillus, on the irrigated rice stand, conducted under different sowing systems and different distances from the woods, Taim/RS/Brazil, 1995.*



	50 m Water-seed	300 m Mix	500 m No-tillage	1000 m Conventional	1500 m Water-seed
Clusters with distinct letters differ between them on the Duncan test, at the 1% probability level					
Number of replications	27 10 10	4 3 3	8 14 28	6 14 15 11	4 9 15 12
Average reduction in each cluster	84 47 18	40 26 8	61 32 11	54 37 20 7	69 40 21 9
Coefficient of variation, *cv* (%)	16,5	16,7	27,3	17,6	20,2
In-cage mean (pl/m²)	57,7 a	55,1a	100,7a	67,8 a	90,5 a
Out-cage mean (pl/m²)	18,7 b	40,1 b	73,7b	49,6 b	69,5 b
Coefficient of variation, *cv* (%)	29,1	6,7	11,4	7,3	6,2
Means followed by vertical different lowercase letters differs between them on the Duncan test, at 1% probability level					
Mean difference in/out of cages (pl/m²)	39,0	15,0	27,0	18,2	22,0
General mean reduction (%)	57,9 A	24,9 B	22,1B	25,4B	25,1B
Coefficient of variation, *cv* (%) 35,3					
Means followed by horizontal different uppercase letters, differs between them on the Duncan test, at 1% probability level					

Figure 11. *Average reduction caused by A. ruficapillus, on the irrigated rice production during different cultivation stages and at different distances from woods, Taim/RS/Brazil, 1996*



	50 m Milk	50 m Mass	1000 m Milk	1000 m Mass
Clusters with distinct letters differ between them on the Duncan test, at the 1% probability level	c	c	c	b c
Number of replications	1 11 14	6 8 11	4 11 10	9 11 6
Average reduction in each cluster	60 36 13	38 21 7	38 27 12	27 14 3
Coefficient of variation, *cv* (%)	28,8	28,0	18,2	21,7
In-cage mean (kg/ha)	4739 a	4939 a	4322 a	3594 a
Out-cage mean (kg/ha)	3490 b	4014 b	3358 b	3014 b
Coefficient of variation, *cv* (%)	16,0	10,1	12,8	8,5
Means followed by vertical different lowercase letters differs between them on the Duncan test, at 1% probability level				
Mean difference in/out of the cages (kg/ha)	1249	925	964	580
General mean reduction (%)	26,4 A	18,7 A	22,3A	16,1 A
Coefficient of variation, *cv* (%) 33,7				
Means followed by horizontal different uppercase letters, differs between them on the Duncan test, at 1% probability level				

5.1.2. The relationship between the avifauna and the irrigated rice crop in the Southern of Rio Grande do Sul, Brazil[10]

Between 27 of November of 1996 and 30 of July of 1997, 17 visits were made to Quatro Irmãos Farm, Rio Grande county, Rio Grande do Sul. Of these, 9 covered the development stages of the rice between the vegetative stage and harvest, and the others were dedicated to the stubble.

At each visit, a significant amount of the field crop was traversed. It was seeded between the 6th and the 9th of November 1996, with the BR-IRGA 410 cultivar, pre-germinated cultivation system, and harvested around the 19th of March 1997. The survey was performed with the aid of a pair of 12x50 binoculars and a voice recorder. The crop was divided into 7 environments: paddy, stubble, irrigation system, levee, vegetation beside the access roads, low vegetation on the beds of secondary roads and eucalyptus stands. The number of individuals of each species presented at each survey was converted to a scale of relative abundance: rare (1 to 5 individuals), uncommon (6 to 20), common (21 to 100), frequent (101 to 1000) and abundant (over 1000).

Ninety-two bird species were identified on the crop, and of those, fifty-two were recorded on the paddy, including eleven that hunt flying above the crops, four associated to weeds and five generalist passerines. Another 24 species were recorded only on the stubble. Discarding those that hunt while flying over the crop and generalist passerines, the species with higher frequency of occurrence during the crop were *Plegadis chihi*, *Ciconia maguari*, *Dendrocygna viduata*, *Amazonetta brasiliensis*, *Aramus guarauna*, *Gallinula chloropus* and *Fulica leucoptera* (66,6%). Considering the minimum numeric value of the relative abundance scale, the most abundant species during the crop was *Plegadis chihi*, followed by *Casmerodius albus*, *Mycteria americana*, *Pluvialis dominica*, *Tringa flavipes*, *Larus maculipennis* and *Sicalis luteola* (excluding *A. ruficapillus*). Of these, 85.7% are carnivorous or preferably carnivorous.

On the initial stages of tilling, the predominant species were waders of shallow waters with low vegetation, including migratory birds recently arrived from the Arctic (*e.g. P. dominica*, *T. flavipes*). While the rice grows, concurrently with the development of aquatic macrophytes, invertebrates and small vertebrates, carnivorous wading birds tend to dominate the crop. From the flowering onwards, only species adapted to dense vegetation are recorded on the paddy. With the draining of the paddy for the harvest, there is a reduction of species present on the crop.

Finally: *Sicalis luteola* can cause some damage to the milky grain, but this species was only recorded in association with *Echinochloa crusgalli*. Studies are necessary to evaluate if *P. chihi* and *D. viduata* cause damage to the plantlets and also to evaluate if the chemical control of *A. ruficapillus* directly threatens *Falco peregrinus* and *Circus cinereus*.

Generally speaking, the rice crop behaves as a shallow paludal environment, of constant hydric balance. It is dominated by monospecific vegetation of accelerated development, with high biomass, rich biodiversity and intricate trophic relationships. The rice crop can be considered of extreme importance to the biological cycle of many bird species during the dry summer season.

---

[10] Dias, R. A.[1], Cirne, M. P.[1] Silva, J. J. C. da[2]

[1] Universidade Católica de Pelotas, caixa postal 402, CEP 96001, Pelotas-RS, Brazil

[2] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

Note. This experiment is part of the project 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research centre for the temperate climate region, Brazil).

5.2. The cause of the Blackbird population increase

Firstly, outcomes concerning bio-ecological aspects and the number of Blackbirds are outlined, modeling studies are then presented, out of which possible causes for the exaggerated increase of the Blackbird population are identified.

5.2.1. Bio-ecological aspects of the *A. ruficapillus*, and its interaction with irrigated rice in Southern Brazil[11]

The objective of this work is to provide a preliminary and complementary description of diverse aspects related to the bio-ecology of the *A. ruficapillus* — a paludal, nomadic, polygenic, gregarious and omnivorous bird — associated with the rice culture.

The Blackbird, during the period of rice maturation, causes severe damage to the crop, since its feeding is based on the "milking" of the milky and mass grains, sucking the starch, as well as during the repining phase, when the bird rolls the grain in its beak, peeling and swallowing it. The areas attacked by the Blackbird during the milky and mass stage can be identified by the presence of starch adhered to the external walls of the panicle. The preferred foraging areas have been identified to be the ones near woods, irrigation channels with great concentration of invading plants and in the interior of the crop, in areas with weeds.

The males of *A. ruficapillus* are territorialists, being restricted, in the reproductive season, to an area of 600 m2. During the night, a great number of males stay within the crop area. They breed with several females and do not have one exclusive breeding male. The females move around and stay almost all the year in flocks, followed by first-year fledgelings and some adult males.

The rice fields can be considered as artificial marshes which provide favorable conditions for nestbuilding, such as dense vegetal cover, abundant food, humidity, protection, shelter against predators and a place to rest.

The nestbuilding starts when the rice plant extends the panicle structure. This structure has greater resistance and conditions to sustain the nest. This period extends from the end of January until the beginning of the rice harvest. The highest occurrence of nests coincides with the period of rice maturation. In natural conditions, the reproduction period last from September to May (spring to autumn).

The building of the nests is an exclusive duty of the males, whereas the females examine and sheathe the oologic chamber with floral structures of *Panicum sp.*, *Digitaria sp.* and *Cynodon sp.*. This female behavior seems to be a sign of acceptance of the nest and consequently of the male for mating. Some females, driven away by males, were seen invading the territory and pillaging nests, removing these fibers.

It was evident that the reproductive activities occur with higher incidences around the crops where the arboreal limits of the rice fields consist of *Acacia mollissima*, *Pinus sp.*, *Eucalyptus sp.*, *Calliandra seloi* and others which can supply favorable conditions during the reproductive period. Reproductive activities were also observed along the irrigation channels where the invading plants are predominant. Nests were observed on the extremities of eucalyptus branches at more than 8 meters from the soil. The reproductive activities in the interior of the crop occurs mostly when there are concentrations of invading plants, such as: *Paspalum sp.*, *Panicum sp.*, *Cyperus sp.*, *Echinochloa sp.* and *Sagittaria montevidensis*.

---

[11] Cirne, M. P.[1]; Silva, J. J. C[2]. da; & Bastos, M. C[1].

[1] UCPel, caixa postal 402, CEP 96100, Pelotas-RS, Brazil

[2] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

Note. This experiment is part of the project 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research centre for the temperate climate region, Brazil).

Three-hundred-sixty-six nests were subjected to a process of biometry, exhibiting the following measurements: mean distance from water 377.02 mm (750-115 mm); mean depth of the oologic chamber 87.26 mm (130-50 mm); mean external diameter of the nests' mouth 106.33 mm (130-82 mm); mean internal diameter of the nests' mouth 77.89 mm (100-59 mm) and external nests' height 117.6 (250-72 mm).

From the same 336 examined nests, a general average of 1.59 eggs per nests was obtained. The lower distance of the nest to the water body, within the rice area, seems to indicate a greater reproductive success. Nests built at an low height (115 mm) displayed a mean clutch of 3.61 eggs.

The material used for building the nest was made up basically of wet vegetal fibers (*Sagitaria montevidensis* e *Scirpus sp.*). Other materials were also found, such as plastic from fertilizer and seed bags. Strings and *Tillaandsia usneoides* was observed on different nests and only once.

5.2.2. The Blackbird population (*A. ruficapillus*) in Rio Grande, RS, Brazil,1994-97[12]

In the last few years, the population of *A. ruficapillus* has increased significantly. This bird is gregarious, being found both in small and large flocks during the whole year. The abundance of *A. ruficapillus* has been studied, relating it with food available, the different phases of the rice culture, and the seasons of the year.

The data were obtained through the transect method, on Granja 4 Irmãos/Taim, and along the road between Vila da Quinta and Pelotas. A direct count was used for situations where isolated birds or small flocks were found, while estimation was employed to count large groups. One-hundred-and-fifty-three trips were made in the 68-km road stretch that connects the EMBRAPA-CPACT/EETB to Rio Grande (Map 3). In this stretch, the count by estimation was restricted to the birds found feeding on both roadsides, from the driver's point of view.

It was observed that during the year the population of this bird on the road diminishes during the period of rice cultivation, and increases during the non-cultivation period. The maximum peak is reached in September (preceding the beginning of rice sowing) and by the end of May (end of harvest), while the minimum occurs in March, before the harvest (Figure 12). The greater population in the months of August and September of 1994, when compared to 1996, was due to large losses of rice during transport of the harvest as a consequence of road maintenance in 1994. In 1995, with better road conditions, the rice losses decreased, which reflected in a smaller bird population. The delay in the increase of the population in the months of March and April of 1995, as compared to 1997, is due to the delay of the harvest in 1995 caused by unfavorable weather conditions for the rice crop that year (Figure 12).

Ninety-six trips were made on 80 km of roads inside the Granja 4 Irmãos (Map 3). Birds found up to 200 m from each side of the road were counted. It has been observed that the bird population was at its peak in the periods of rice sowing and harvesting (Figure 13). The data indicates that a small decrease occurs in the population during the rice phenologic development period, and a greater decrease during the non-cultivation period, specially at winter's end (Figure 13). In March, when the harvest commences, the birds stay practically all the time inside the crop. At the end of the harvesting period they concentrate on the farm's

---

[12] Cirne, M. P.[1], Silva, J. J. C.[2], Franco, D. F.[2], Vieira, M. M[1]; & Freitas. R. A.[1].

[1] UCPel, caixa postal 402, CEP 96100, Pelotas-RS, Brazil

[2] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

Note. This experiment is part of the project 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research centre for the temperate climate region, Brazil).

main houses, feeding on the residue of the rice's pre-cleaning, which is composed of seeds of weeds and rice grains (whole and broken). In this period they are also found on the roads used to transport the rice, feeding on rice grains that fall from the trucks during transport.

Parallel to this study, more than 1200 birds were ringed and returned to the environment, with recaptures only in the studied area (Granja 4 Irmãos). It was also observed that the birds remained in the project area (nearby places with greater food availability) during the period when there was no rice cultivation. These observations suggest that *A. ruficapillus* can be considered a resident bird.

Map 3. *Itineraries used to carry out the A. ruficapillus population surveys. Pelotas, 1997.*

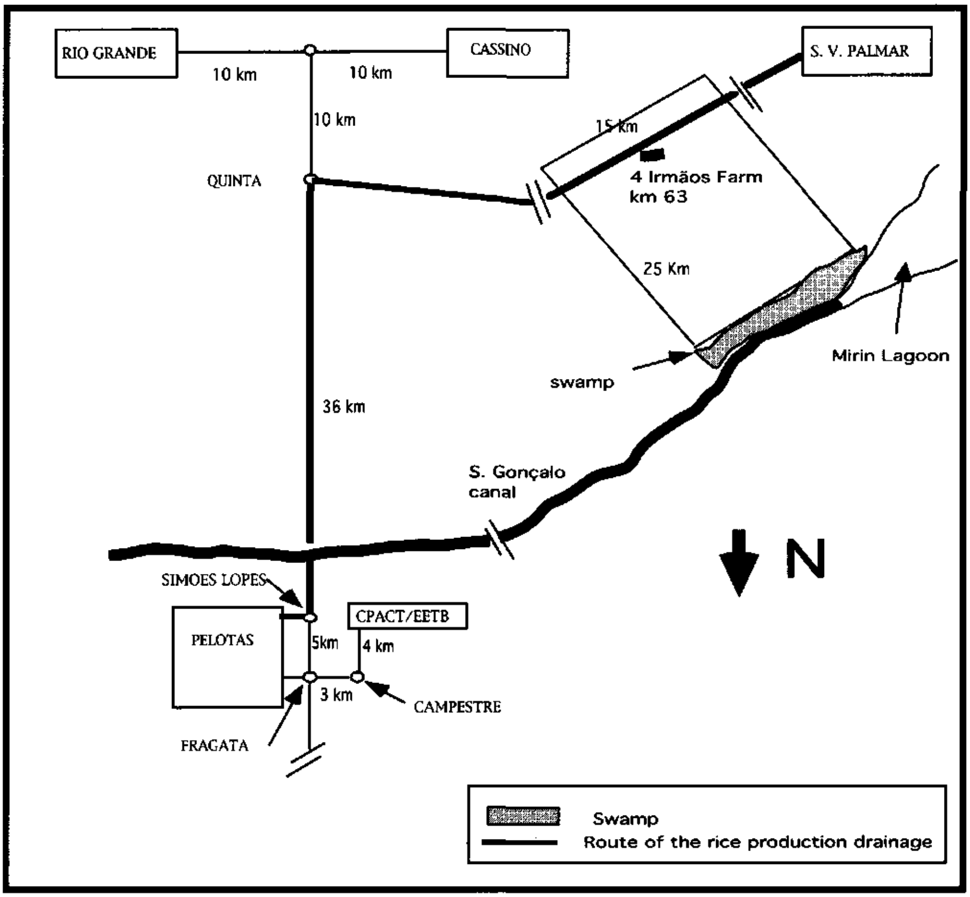


Figure 12. *Monthly number of A. ruficapillus feeding on rice residues along the road sides between Rio Grande and EMBRAPA-ETB/CPACT, 1994-95 and 1996-97.*

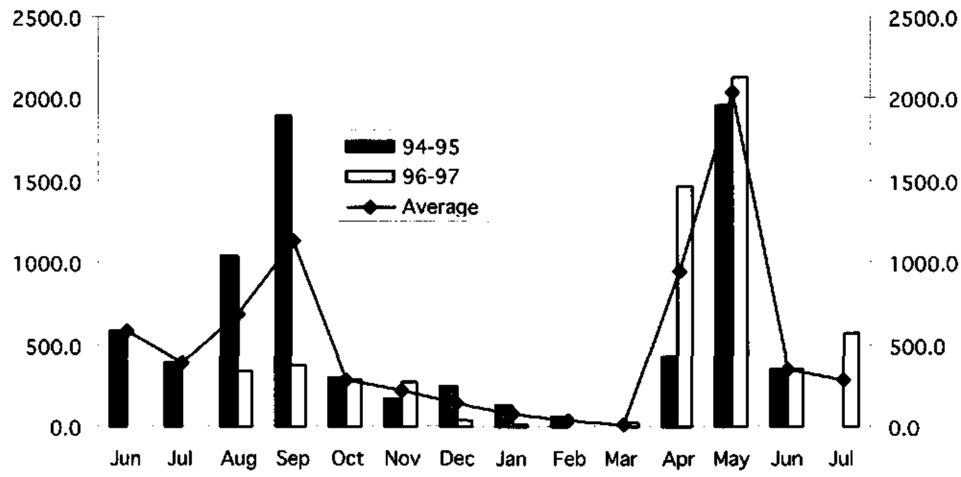
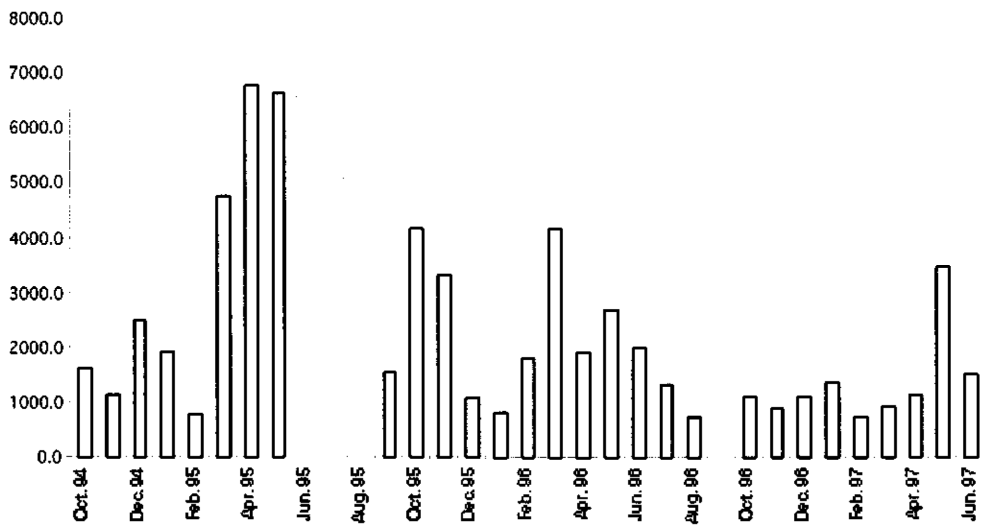


Figure 13. *Monthly number of A. ruficapillus on Granja 4 Irmãos, Rio Grande, RS, 1994-97.*



5.2.3. Identification of the Blackbird (*A. ruficapillus*) feeding regime in the coastal plain of the Mirim lagoon, RS, Brazil, 1994-96[13]

To identify and quantify the main components of the feeding diet of *A. ruficapillus* in the coastal plain of the Mirim Lagoon, 31 birds were caught using Mist Nets during Nov 94 and Nov 96 and sent to the laboratory for analysis of stomach content.

The samples, with a maximum number of 20 individuals by sampling point, were done near the crops, in internal roads, near the houses and over rice cleaning residues during sowing, harvest and "no-crop" periods, on Granja 4 Irmãos, located in Taím/RS. The collected birds were kept frozen at -16°C for an indefinite period at the ornithology laboratory of UCPel, for later removal of the stomach contents. After removal, the material was put in labeled jars, with alcohol 70°, being immediately sent to the Seed Analysis Laboratory of the EMBRAPA CPACT for identification of seeds.

Twenty-five species of seeds were identified in the analysis of the stomach contents (Table 14), the most frequent being: *Oryza sativa* (47.16%), *Echinochloa sp.* (18.70%), *Paspalum sp.* (12.03%), *Panicum sp.* (7.89%), *Digitaria sp.* (6.57%), *Abronia fragrans* (3.78%), *Agrostis sp.* (1,32%), *Anthoxanthum odoratum* (0.76%), *Axonopus sp.* (0.49%), and *Hipoxis decumbens* (0.31%). *Solanum sp., Setaria sp., Poligunum persicaria, Fimbristylis baldwiiniana, Silene antirhina, Cyperus sp., Eleocharis sp., Rumex sp., Eragrostis sp., Cynodon dactylon, Carex sp., Trifolium sp., Sida sp., Trifolium repens,* and *Cyphea sp.*, which totalled 0.99% of the identified material were also found.

During the sowing period, the feeding regime in 94/95 was mainly *Oryza sativa* (61.8%), *Echinochloa sp.* (21.0%), and *Digitaria sp.* (8.7 %). In 95/96 crop, it was *Oryza sativa* (74.7%), *Echinochloa sp.* (20.3%), and *Panicum sp.* (3.8%). During the harvesting period, the feeding regime in 94/95 was mainly *Oryza sativa* (46.3%), *Paspalum sp.* (37.6%), and *Echinochloa sp.* (13.3%), and in 95/96 was mainly, *Oryza sativa* (78.9%), *Echinochloa sp.* (9.6%), and *Axonopus sp.* (5.3%). During the "no crop" period, the feeding regime in 1995 was mainly, *Echinochloa sp.* (22.3%), *Digitaria sp.* (17.0 %), *Paspalum sp.* (16.2%), *Oryza sativa* (15.3%), *Panicum sp.* (14.5%), *Abronia fragrans* (10.4%), and *Agrostis sp.* (3.3%); and in 1996 was mainly *Oryza sativa* (34.0%), *Paspalum sp.* (20.1%), *Panicum sp.* (16.4%), *Abronia fragrans* (15.1%), *Echinochloa sp.* (13.9%) and *Digitaria sp* (0,2%).

[13] Franco, D. F.[1];Cirne, M.P.[2]; Silva, J. J. C.[1]; Asmus, M. L.[3]; & Macedo, V.L.C.[1]

[1] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

[2] UCPel, caixa postal 402, CEP 96100, Pelotas-RS,

[3] Deptº de Oceanografia - FURG, caixa postal 474, CEP 96201-900, Rio Grande-RS, Brazil

Note. This experiment is part of the project 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research centre for the temperate climate region, Brazil).

Table 14. *Average percentage of the seeds most usually found in the analysis of the stomach contents of A. ruficapillus, collected from 11.1994 to 11.1996, on Granja 4 Irmãos, Rio Grande, RS, Brazil. EMBRAPA-ETB/CPACT, Pelotas, 1997*

Scientific name	Common name	Mat.**	Sowing	Harvesting	No-crop	Average***
Oryza sativa	Arroz (Rice)	S/SU	68,3	62,6	24,7	47,16
*Echinochloa sp**	Capim-arroz	SU	20,6	11,5	18,1	18,70
*Paspalum sp**	Capim colchão	S/SU/A	0,6	19,0	18,2	12,03
*Digitaria sp**	Milhã	S/SU	4,4	0,0	8,6	6,57
*Panicum sp**	Grama	S/SU	3,4	1,0	15,5	7,89
*Abronia fragrans**		S/SU	0,5	1,3	12,8	3,78
Agrostis sp	Capim mimoso	W	0,6	0,0	1,7	1,32
A. odoratum	Feno-de-cheiro	SU	1,0	1,1	0,0	0,76
Axonopus sp	Grama-fôlha-larga	SU	0,1	2,7	0,0	0,49
Hipoxis decumbens	Falsa tiririca	SU	0,3	0,0	0,0	0,31
Other species			0,6	1,0	0,8	0,99
Solanum sp.	Joá					
Setaria sp.	Cola-de-zorro	SU/A				
*P. persicaria**	Erva pessegueira	SU/A				
*F. balwiniana**	Falso-alecrim	W/SU				
Silene antirrhina	Alfinete da terra	W				
*Cyperus sp.**	Junquinho	S/SU				
*Eleocharis sp.**	Junco-manso	S/SU				
Rumex sp.	Lingua de Vaca	SU/A				
Eragrostis sp.	Capim-mimoso	SU/A				
Cynodon dactylon	Grama seda	SU/A				
Carex sp.	Capim junco	-				
Trifolium sp.	Trevo	S/SU				
Sida sp.	Guanxuma	SU/A				
Trifolium repens	Trevo branco	S/SU				
Cuphea sp	Guanxuma verm.	SU				

* Rice Weed species in Rio Grande do Sul

**Mat (maturation period): S (Spring), SU (Summer), A (Autumn), W (Winter)

***Of all samples

5.2.4. Identification of seeds found in the residues of the rice crop harvested in Rio Grande, RS, Brazil, 1997[14]

Different seeds of other vegetal species, mainly weeds, are harvested together with rice during the harvesting process. These seeds, after being separated from the rice in the cleaning process, will be part, with inert materials, of the so-called "residues", piled up in rural properties. These seeds, together with broken and whole rice seeds, are available for the blackbird (*A. ruficapillus*) the year round.

[14] Silva, J. J. C.[1]; Franco, D. F.[1];Cirne, M.P.[2]; Asmus, M. L.[3]; Macedo, V.L.C.[1]; & Silva; M. D.[2]

[1] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

[2] UCPel, caixa postal 402, CEP 96100, Pelotas-RS, Brazil

[3] Deptº de Oceanografia - FURG, caixa postal 474, CEP 96201-900, Rio Grande-RS, Brazil

Note. This experiment is part of the project 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research centre for the temperate climate region, Brazil).

The objective of this work was to identify and quantify seeds that are mixed with rice during harvest, in order to supplement work that deals with the blackbird diet. For that purpose, recently harvested rice samples were collected on three occasions during the 1997 harvest (April 03, April 24 and May 01) directly from the trucks coming from the field and from the rice residue pile out in the open, on Granja 4 Irmãos, Taím – RS. The material collected was identified and immediately forwarded for identification in the Seed Laboratory of EMBRAPA/CPACT.

In the residues analyses, derived directly from the field, 12 seed species were found, which comprised 2% of the residue (Figure 14). The most frequent species (Figure 15) were: *Echinochloa sp.* (72%), *Paspalum sp.* (9%), *Abronia fragrans* (4%), *Panicum sp.* (3%), and Cruciferae family (2%). *Cyperus sp., Panicum brevifolium, Poligonum punctatum, Paspalum dilatatum, Vigna marina,* black-rice, red-rice, Gramineae family, and Compositae family were also found, which amounted to 10% of the identified material.

During the beginning of the harvest period, seeds from other plants represented 4% of the residue, with the prevalence of *Echinochloa sp.* (80%), *Paspalum sp.* (8%), and the remaining 12% being composed of diverse seeds. In the middle of the harvest, the seeds of other plants represented 1% of the residue, with the prevalence of: *Echinochloa sp.* (45%), *Paspalum sp.* (21%), *Panicum sp.* (8%), Cruciferae family (7%), *Abronia fragrans* (4%), with the remaining 15% composed of diverse seeds. At the end of the harvesting period the seeds of other plants represented 2% of the residue, with the prevalence of *Echinochloa sp.* (81%), *Abronia fragrans* (10%), *Panicum sp.* (2%), Cruciferae family (2%), with the remaining 4% composed of diverse seeds.

It was identified that the harvest's residue pile was composed by 86.8% of inert material, 12.1% of rice (whole and broken grains) and 1.1% of other species. With the exception of rice, the most frequent species (Figure 16) were: *Echinochloa sp.* (35%), *Paspalum sp.* (21%), *Setaria sp.* (9%), *Digitaria ciliaris* (9%) and *Abronia fragrans* (7%). *Cyperus sp., Paspalum dilatatum, Eleocharis sp., Panicum brevifolium, Paspalum plicatum, Kyllinga sp., Paspalum notaum, Cyperus esculentum, Gallium sp., Panicum sp. Lolium multiflorum, Fimbristylis baldwiniana, Paspalum urvillei* and Chenopidiaceae family were also found which amounted to 28% of the identified material.

In possession of this result a correlation analysis was done between the seeds most found in the analysis of the stomach contents of *A. ruficapillus*, during winter time (previous work) and most seeds found in the analysis of the rice residue pile, resulting in 6 pairs of points. In order to process the analyze the 12,1% (whole and broken rice) and 1,1% of other species were considered as 100%. The inert material was not considered. Table 15. show values applied to process the correlation analyze.

Table 15. *Seeds found in the stomach content of A. ruficapillus, during winter time, and seeds found in the residue pile of rice harvested on Granja 4 Irmãos, Rio Grande. EMBRAPA-CPACT. Pelotas- RS, Brazil. 1997.*

Species (seeds)	Stomach content (%)	Residue pile (%)
Rice	24,6	91,8
Echinocloa	18,1	3.0
Paspalum	18,1	1,1
Digitaria	8,5	0,9
Abronia	12,7	0,7
Other seeds	18,0	2,5
Total	100,0	100,0

The analysis of values in table 15 shows a correlation coefficient (r) equal to 0,7224 with t equal to 2,889 significant at 10,44% level. It can be seen that the significance is not high. The low significance is due to the low number of pairs (6). However the value of r can be considered significant. It means a high correlation between seeds found in the stomach content of *A. ruficapillus* during winter time and seeds found in the rice residue pile.

This result supports the hypothesis that the blackbird has been using these seeds as an alternative food source during winter, avoiding death by starvation for a substantial proportion of its population. This alternative food source can be considered as one of the main factors responsible for the abnormal increase in this birds' population.

Figure 14. *Components of the residue from the rice harvested on Granja 4 Irmãos, Rio Grande. EMBRAPA-CPACT. Pelotas- RS, Brazil. 1997.*

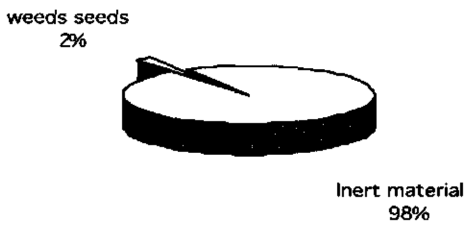


Figure 15. *Species found in the rice harvested on Granja 4 Irmãos, Rio Grande. EMBRAPA-CPACT. Pelotas- RS, Brazil. 1997.*

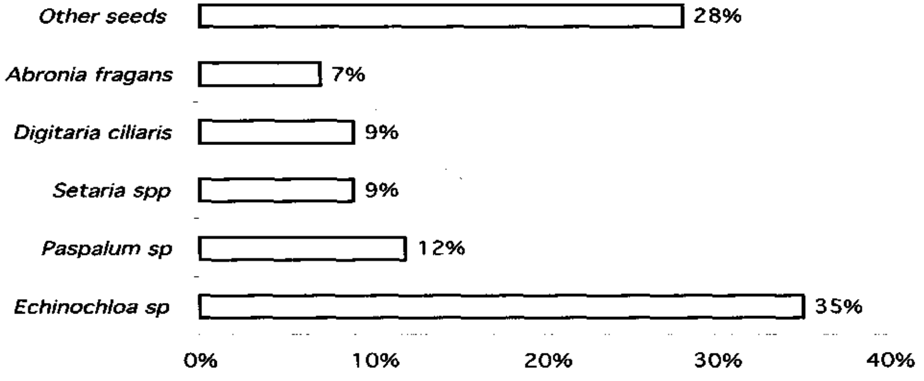
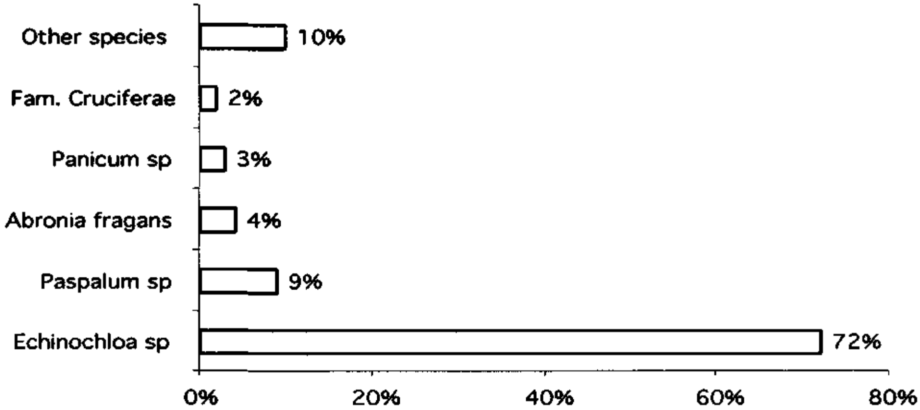


Figure 16. *Species found in the rice residue, stocked in the open, on Granja 4 Irmãos, Rio Grande. EMBRAPA-CPACT. Pelotas-RS, Brazil. 1997.*



5.2.5. Food available for the Blackbird (*A. ruficapillus*) on roads during transportation of rice crop production of Southern region of Rio Grande do Sul, Brazil[15]

The rice that is lost by trucks on the roads during transport serves as food for the blackbird (*A. ruficapillus*). The objective of this work was to quantify these losses, in order to supplement studies aimed at the identification of causes for the population increase of this bird.

On 10.04.94, the quantity of rice found on the roadsides of the Rio Grande-Pelotas road was estimated (Table 16). In road stretches where the asphalt conditions were satisfactory, the rice layer found was on average 33 m long, 2.3 m wide, with 5.8 cm deep at 10 cm from the roadside and 2.0 cm deep at 100 cm from it. In the road stretches where the asphalt conditions were bad, the rice layer found was, on average 87 m long, 3.0 m wide, with 13.8 cm deep at 10 cm from the roadside, and 5.5 cm deep at 100 cm from it. At this time, almost all the road was in a bad condition and it was practically impossible to find any part of it not covered in rice. It can be added that the road sections in good condition at that time would be considered of terrible quality in 1997.

On 22.04.94 the quantity of rice found on the bridge between the counties of Rio Grande and Pelotas, which spans 1020 m, was evaluated. Losses of 39480 g of dry rice were observed in a period of 4 hours, which implies in an average loss of 9680 g of rice in one hour/km.

---

[15] Silva, J. J. C.[1]; Franco, D. F.[1]; Cirne, M.P.[2]; Asmus, M. L.[3], Miguens, H. V. S.[4]; & Antunez, D. M.[2]

[1] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

[2] UCPel, caixa postal 402, CEP 96100, Pelotas-RS, Brazil

[3] Deptº de Oceanografia - FURG, caixa postal 474, CEP 96201-900, Rio Grande-RS, Brazil

[4] JOSAPAR, Marcílio Dias 2195, CEP 96100, Pelotas-RS, Brazil

Note. This experiment is part of the project 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research centre for the temperate climate region, Brazil).

During April 1997 the minimum mean loss on the roads used to transport the crop (Table 17) was quantified. To obtain the data, plastic tarpaulins 25 m long and 4 m wide were spread along the roadsides of the BR 471, in a stretch where the road surface was in excellent condition. The grain that fell in the tarpaulin was collected, being weighted later, in the laboratory. It was identified that the crop transportation, in that season, was carried out 45.5% by wagon-trucks of 27 t., 45.2% by 15 t. trucks, and 9.3% by 12 t. trucks, the last two being the ones that had, visually, large losses.

The minimum mean rice loss was of 0.16%/ton/100 km, which means that, when considering an average productivity of 6 ton/ha in 800,000 ha, the loss would reach 7,680 tons. These losses could be converted into US$ 1,843,200.00 (US$ 12.00/50 kg sac), or even that these losses would come to 26,6 kg/km/day — if we consider that the trucks travel approximately 100 km between he properties and the rice mills.

From this work we can conclude that: a) this kind of loss represents a significant increase in the food available to the population of *A. ruficapillus*, especially during the autumn/winter period; b) the rice lost during the harvest transport can be considered as one of the causes of its population increase, since it reduces the natural mortality of the population and stimulates *A. ruficapillus* females to reproduce without control; c) this information should stimulate a campaign to reduce the transport losses of the rice crop in order to reduce the population of ***A. ruficapillus*** in the area, in an integrated management program, and consequently reduce bird damage to irrigated rice crops.

Table 16. *Rice grains found on the roadside along the Rio Grande-Pelotas road, RS, April 1994. EMBRAPA-ETB/CPACT, Pelotas, 1997.*

Sample	Asphalt conditions	Width (m)	Thickness (cm) 10-100 cm of asphalt	Length (m)
1	satisfactory	2,8	5/1	45
2	satisfactory	3,1	8/3	33
3	satisfactory	1,1	3/1	19
4	satisfactory	1,9	7/1	36
Mean		2.3	5,8/2,0	33
5	Bad	3,5	16/8	120
6	Bad	3,0	14/5	135
7	Bad	2,3	11/6	53
8	Bad	3,2	14/3	40
Mean		3,0	13,8/5,5	87

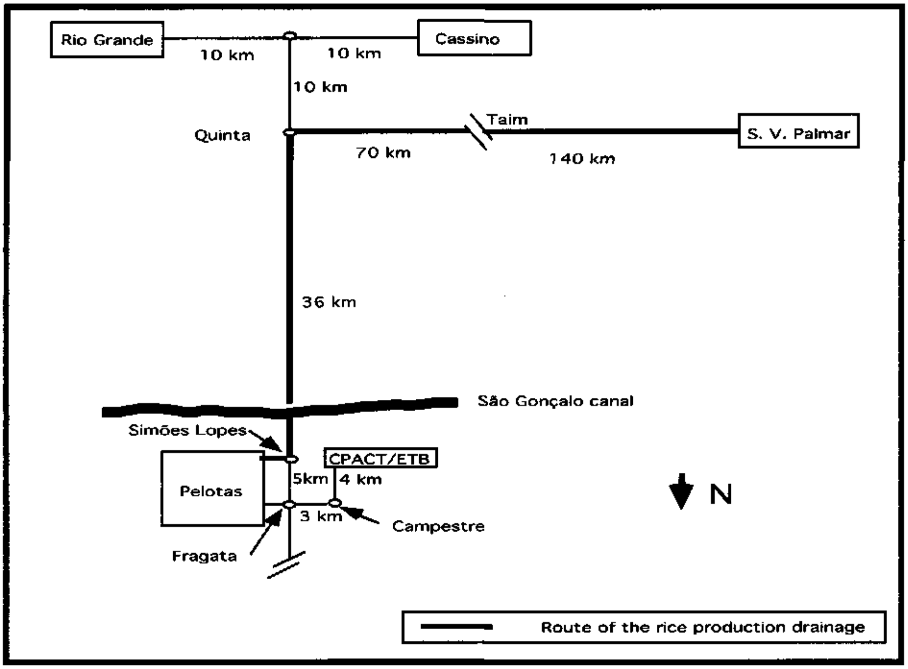
Table 17. *Rice losses and load of truck used for transport, during the transportation of the rice crop, on the BR 471 (Rio Grande- Sta. Vitória), EMBRAPA-ETB/CPACT, Pelotas, 1997*

	2 April		**9 April**		11 April		**Mean**
Total load (ton)	no.	%	**no.**	**%**	no.	%	**%**
27	4	66,7	**11**	**42,6**	4	27,1	**45,5**
15	2	18,5	**23**	**49,4**	18	67,8	**45,2**
12	2	14,8	**5**	**8,0**	2	5,1	**9,3**
Period of observation (minutes)	136		**330**		120		**195**
Losses (g / 25m)	62		**349**		120		**177**
Losses (% ton per 100 km)	0,15		**0,20**		0,12		**0,16**

5.2.6. Identification of the losses of rice during transportation along the Rio Grande road, and how it can be seen as an alternative food source for the Blackbird (*A. ruficapillus*) – Pelotas, RS, Brazil, 1997[16]

The objective of this work was to study the Blackbird population (*A. ruficapillus*), feeding on the rice lost by trucks along the roads to processing centers and relate it to the cargo flow, rice crop stage and seasons in order to understand the blackbirds' feeding habits and aid studies related to the identification of causes of its population increase.

One hundred and fifty-three trips were made on a 68 km road stretch which connects the EMBRAPA-CPACT/ETB to Rio Grande, 36 km of which has a flow of trucks transporting rice travelling on it (Map 4). The approximate count was restricted to birds found feeding on both sides of the road, from the motorist's viewpoint.



Map 4. *Route of rice production drainage from Rio Grande and Santa Vitória do Palmar counties. EMBRAPA-CPACT, Pelotas, 1997.*

---

[16] Silva, J. J. C.[1]; Cirne, M.P.[2]; Franco, D. F.[1]; Asmus, M. L.[3]; Miguens, H. V. S.[4]; & Gravato, I. C.[2]

[1] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

[2] UCPel, caixa postal 402, CEP 96100, Pelotas-RS, Brazil

[3] Deptº de Oceanografia - FURG, caixa postal 474, CEP 96201-900, Rio Grande-RS, Brazil

[4] JOSAPAR, Marcílio Dias 2195, CEP 96100, Pelotas-RS, Brazil

Note. This experiment is part of the project 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research centre for the temperate climate region, Brazil).

Initially it can be observed that the presence of *A. ruficapillus* flocks occur only on the stretches of road used by rice-carrying trucks (Table 18), even though the whole road is located in a region with similar environmental characteristics.

Table 18. *Number* of A. ruficapillus, along the road sides between Rio Grande and the EMBRAPA-ETB/CPACT – in Pelotas, at different moments in 1994-95 and 1996-97.*

	months of the period 94/95 and 96/97													
	06	07	08	09	10	11	12	01	02	03	04	05	06	07
Low temp.	■	■	■	■									■	■
Sowing					■	■	■							
Harvest										■	■	■		
stretch** I	0	0	0	1	0	0	0	0	0	0	0	0	0	
II	**580**	**388**	**692**	**1134**	**289**	**221**	**143**	**72**	**35**	**13**	**947**	**2046**	**353**	**284**
III	0	0	0	0	0	0	0	0	0	0	0	0	0	

*. Average from 153 trips

** Stretch: Distance (Km)

I.	Rio Grande - Quinta	20
II	Quinta - S. Lopes (Pel.)	36
III	S. Lopes - CPACT/ETB	12

The analysis, after discarding observations made during periods of heavy traffic and rainy days, indicated that:

a) During the year, the population of this bird along the road decreases during the period of rice cultivation reaching a minimum level in March, which precedes harvest. The maximum peaks are reached in May (end of harvest) and in September (preceding the beginning of rice sowing) (Figure 17). The fact that a greater population was observed in the months of August and September of 1994 than in the same months in 1996 is due to greater rice losses during the harvest transportation as a consequence of the terrible condition of the roads in 1994. In 1995, with the improvement of road surface, the rice losses were reduced, resulting in a smaller bird population. The delay in the population increase in the months of March and April of 1995 when compared to 1997 is due to the delay in the 1995 harvest, caused by climatic conditions which were unfavorable to the rice crop that year. The correlation analysis between monthly rice flow percentage and monthly Blackbird number did not indicate any significance (Figure 18). The absence of statistic correlation is because peak of rice flow occurred during the harvesting period when there were still several fields to be harvested. One observed that the Blackbirds, during the harvest period, stayed on the rice fields being harvested . As the area to be harvested decreased, the Blackbird population increased on the road. At the same time rice flow from May to February is almost the same. In spite of the rice flow, the Blackbird population increased on the road as winter approached. This behavior caused a disturbance in data analyzed and correlation became difficult to demonstrate. However, from figures we may conclude that during winter time, due to a reduction of food supply in the country side and due to rice losses on the road, there is a migration of the Blackbird population from country side to the roads in order to feed from rice lost by trucks.

Figure 17. *Monthly number of A. ruficapillus feeding on rice residues, along the road sides between Rio Grande and EMBRAPA-ETB/CPACT, 1994-95 and 1996-97. EMBRAPA-ETB/CPACT, Pelotas, RS, Brazil, 1997.*

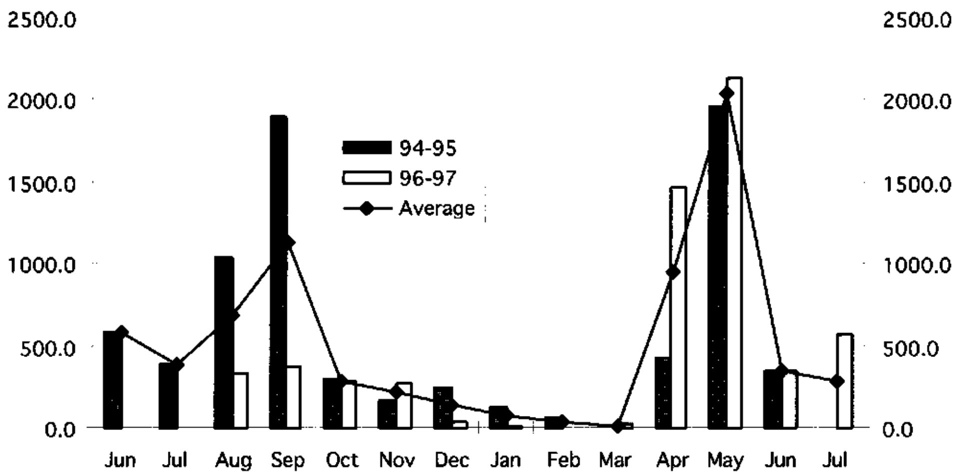
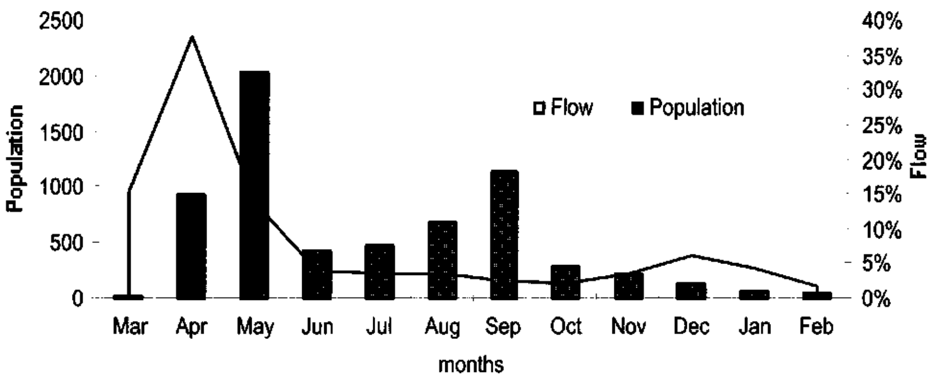


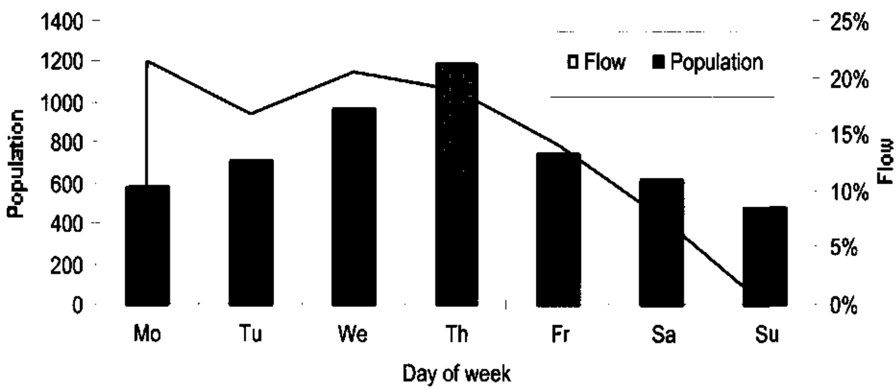
Figure 18. *Average of monthly number of A. ruficapillus feeding on rice residues, along the road sides between Rio Grande and EMBRAPA-ETB/CPACT, and rice flow (%) from Rio Grande and S. V. do Palmar in JOSAPAR mill during the period 1994/97. EMBRAPA-ETB/CPACT, Pelotas, RS, Brazil, 1997.*



b) During the week, the population increases from Monday to Thursday, declining on Friday (Figure 19). These data are explained by the decrease in rice transportation on Saturdays and Sundays, except during the harvest period. The explanation for the population decreasing on

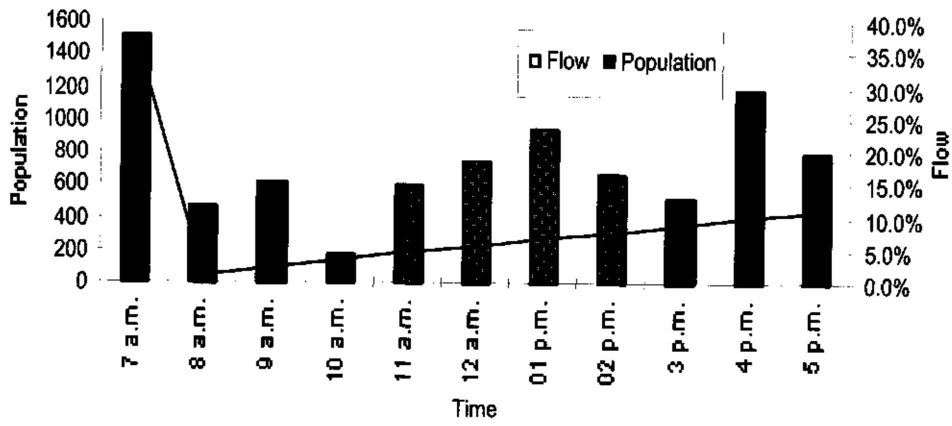
Fridays was given by the farmers of the area, and confirmed by the mill owners (Figure 19). According to them, the flow of trucks on Fridays is smaller in order to avoid the driver having to stay in the city during the weekend if he cannot unload his truck. A correlation analysis was done between rice flow percentage and weekly Blackbird numbers over a two years period, resulting in 14 pairs of points. We did not use the average over two years because it would have resulted in too low a number of degrees of freedom (7 pairs) to do a hypothesis test. The analysis shows significance at 2,26% level indicating a correlation coefficient (r) of 0,60 that is excellent if one considers the randomness.

Figure 19. *Average of weekly number of A. ruficapillus feeding on rice residues, along the road sides between Rio Grande and EMBRAPA-ETB/CPACT, and rice flow (%) from Rio Grande and S. V. do Palmar in JOSAPAR mill during the period 1994/97. EMBRAPA-ETB/CPACT, Pelotas, RS, Brazil, 1997.*



c) during the day the population has a peak in the first few hours, declining steeply soon afterwards, and reaching a balance between 11:00 and 16:00 hours, declining again at the end of the afternoon (Figure 20). The population increase in the first hours of the day is because of rice losses that occurred at the end of the previous afternoon and weren't eaten up. The decrease in the remaining part of the morning is because of the few trucks transporting rice during this period (Figure 20). According to the farmers and mill owners, truck drivers use the morning to load the truck, eat, and only then do they begin their journey. The increase of the population in the afternoon is due to the greater flow of rice transportation, and the decrease by the end of the afternoon is a consequence of the return of the birds to their shelters. To do a correlation analysis between rice flow percentage and Blackbird number during different hours of the day, certain procedures had to be carried out to reduce bias. First we considered just the "rice flow during the no-crop period" as flow percentage. We did it because the rice flow is more intense during the harvesting period and because during this period the Blackbird population is lower than during winter time. Also, we considered night figures as they were 7 o'clock in the morning. We did this because there is a rice flow during the night and because Blackbirds return to their shelters in the evening resulting in an accumulation of rice at night. Finally, because rice flow was related to morning, afternoon and night periods we had to do a linear interpolation. We considered trucks arriving every hour from 8 to 17 o'clock every day (morning: 8; 9;10; 11;12 and afternoon: 13; 14; 15; 16; 17). After determination of P_1 (10; 3,6) and P_2 (15; 9,0) we found the equation line and the interpolation of points. The analysis shows significance at 0,36% level indicating a correlation coefficient (*r*) of 0,80.

Figure 20. *Average of population abundance of A. ruficapillus, at different hours of the day, feeding on rice residues, along the road sides between Rio Grande and EMBRAPA-ETB/CPACT, and rice flow (%) from Rio Grande and S. V. do Palmar in JOSAPAR mill during the period 1994/97. EMBRAPA-ETB/CPACT, Pelotas, RS, Brazil, 1997.*



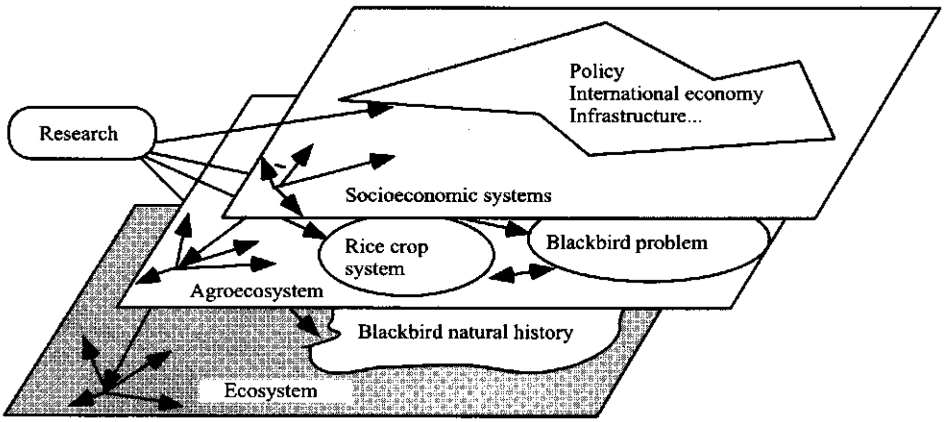
These facts show that this bird identified the losses during rice transportation as an alternative food source, which can be considered as one of the main causes of the abnormal increase in its population. There was no longer a natural decrease in food supply during winter so the increase death rate during this time due to low availability of food, decreased and the laying season of the bird was extended since there was no longer anything to inhibit reproduction.

5.2.7. Ecological modeling of the Blackbird (*A. ruficapillus*) in irrigated rice production areas of Rio Grande do Sul, Brazil[17]

The objective of this work was to create an instrument which will enable integration, through qualitative and quantitative models, of all the existing information about the blackbird (*A. ruficapillus*) gained from different actors and research carried out. It would outline the reflection, investigation and debate of the problems caused by this bird, as well as guide the formulation of measures to be taken in order to reduce or avoid its damage to the rice crop.

Initially the system to be studied was defined and limited, together with its hierarchical levels (Figure 21) and main components related to the blackbird subject.

Figure 21. *Hierarchical structure of the three interaction levels of the population increase of A. ruficapillus in Rio Grande do Sul, Brazil – EMBRAPA/CPACT 1997.*



To identify and understand the different variables, their importance, and how they inter-relate with the problem, a conceptual qualitative model [symbols are based on Odum, 1984] was developed (Figure 22). In this model (conceptual qualitative) the inputs and outputs of the specific problem were identified, in addition to its sub-systems and respective inter-relations. Two basic blocks are emphasized: the first, in the upper part of figure 22, represents the natural components, and the second, in the lower part of the figure, represents the components where the anthropogenic action is more evident, and where the situations responsible for the disruption of the population balance of the blackbird probably occurred.

---

[17] Silva, J. J. C.[1]; Asmus, M. L.[2]; Bonilha, L. E.[3]; Cirne, M.P.[4]; Franco, D. F.[1]; Borges, R[4].

[1] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

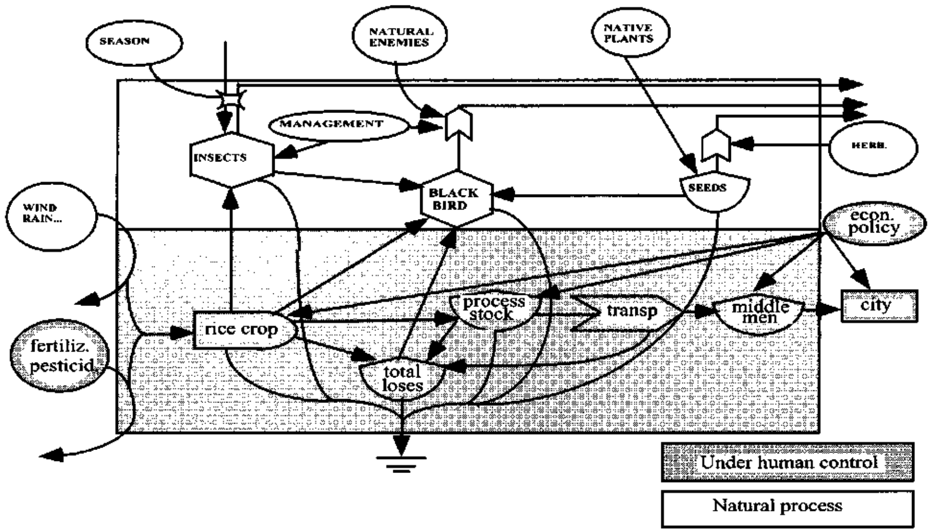
[2] Dept° de Oceanografia - FURG, caixa postal 474, CEP 96201-900, Rio Grande-RS, Brazil

3. UNIVALI, caixa postal 458, CEP 88302-202, Itajai-SC, Brasil.

[4] UCPel, caixa postal 402, CEP 96100, Pelotas-RS, Brazil

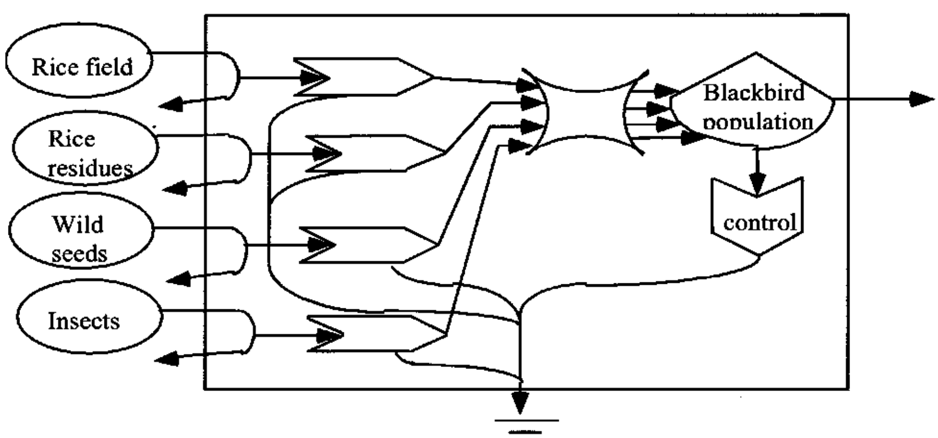
Note. This experiment is part of the project 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research centre for the temperate climate region, Brazil).

Figure 22. *Diagrammatic conceptual model involving the Blackbird problem and irrigated rice in Rio Grande do Sul, Brazil – EMBRAPA/CPACT 1997.*



A deeper analysis of the block under higher anthropogenic action generated the hypothesis that the food availability is one of the main regulators of the bird population (Figure 23 - symbols are based on Odum, 1984).

Figure 23. *Food sources and population control of the Blackbird in the rice production region in Rio Grande do Sul, Brazil – EMBRAPA/CPACT 1997.*



Later, the relationships suggested in the conceptual model were quantified and a quantitative model was developed. In order to do this, the STELLA software (Richmond et al., 1987) was used to build future scenarios. The software uses numerical models of integration and a continuous simulation language [based on Euler's method[18]] with integration routines. The model built permits the integrated simulation of 92 variables, at 15 day intervals over a 30-year period. Figures 24, 25, 26 and 27 exemplify the quantification of some of the proposed relationships and allow building future scenarios.

Figure 24. *Simulates population stability of A. ruficapillus in a situation of no seed residues, from rice cleaning and no losses during transportation. EMBRAPA - ETB/CPACT, Pelotas, 1997.*

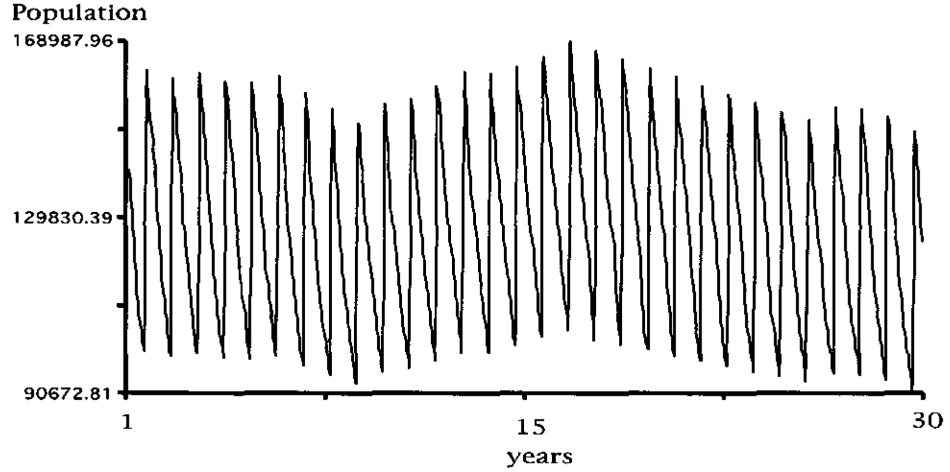
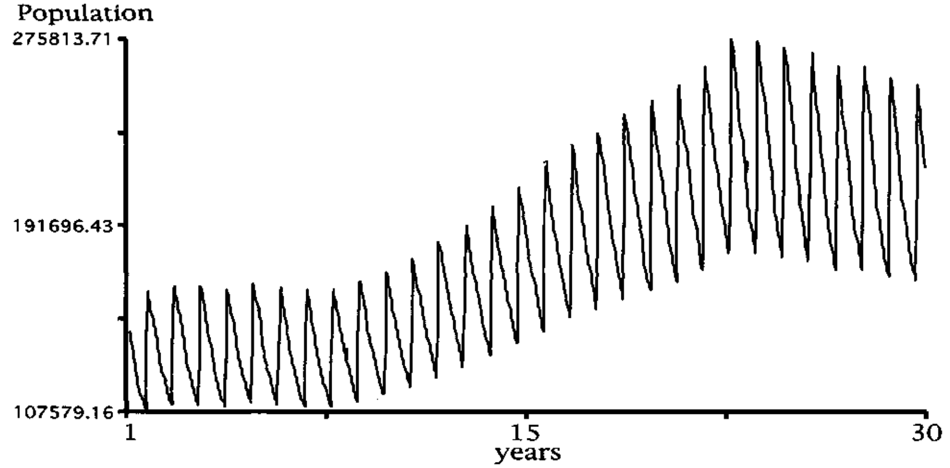


Figure 25. *Simulates population increase of A. ruficapillus in a situation with availability of 1% of residues from rice cleaning, and 1% from losses during transportation. EMBRAPA - ETB/CPACT, Pelotas, 1997.*



[18] An important characteristic of Euler's method is that it assumes a flow is constant over the interval "dt" and is equal to its value at the beginning of the interval (Richmond et al, 1987)

Figure 26. *Simulates population stability of A. ruficapillus in a situation of constant availability of 1% of residues from rice cleaning, and 1% from losses during transportation of rice. EMBRAPA - ETB/CPACT, Pelotas, 1997.*

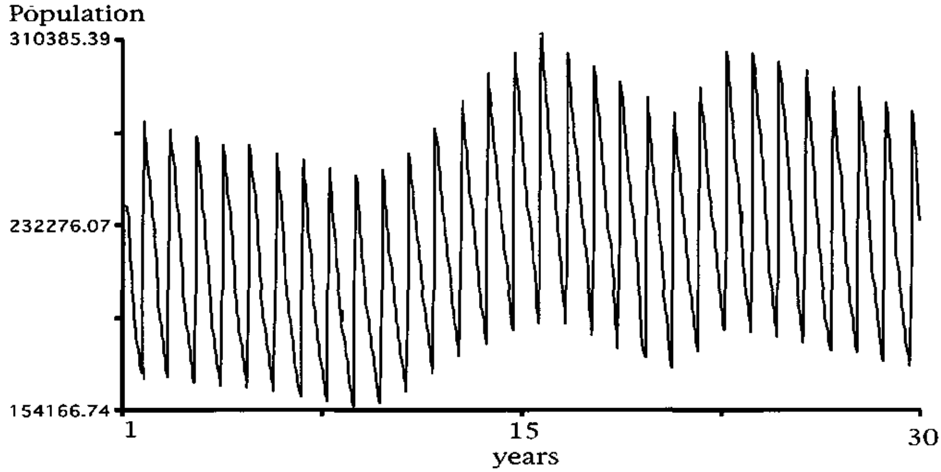
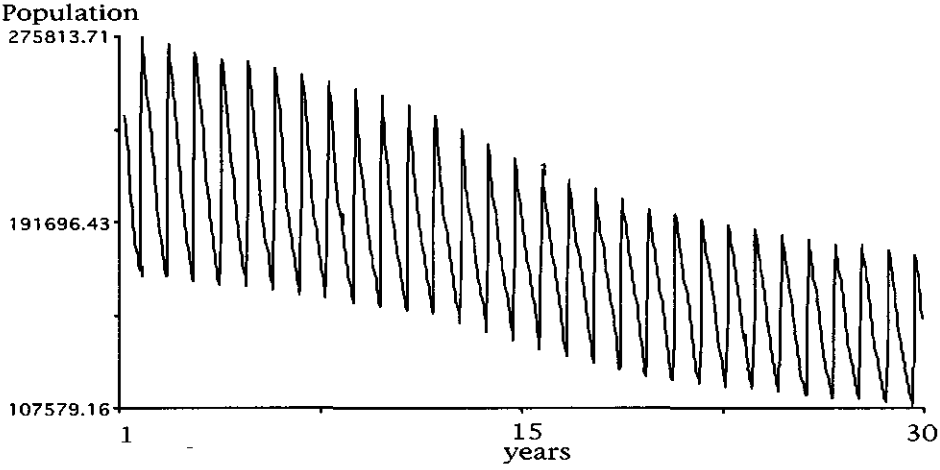


Figure 27. *Simulates population decrease of A. ruficapillus in a situation of removal of the availability of 1% of residues from rice cleaning, and 1% from losses during transportation of rice. EMBRAPA - ETB/CPACT, Pelotas, 1997.*



Such scenarios confirm the possibility that the increase in the *A. ruficapillus* population can be related to a greater food availability during Winter, a season which is usually characterized by fewer grains from wild plants. The availability from anthropogenic sources would arise from rice grains lost during harvest, from the rice that falls from trucks during transport to mills and from the residue (seeds of rice and weeds) accumulated on the rural properties during the process of rice cleaning.

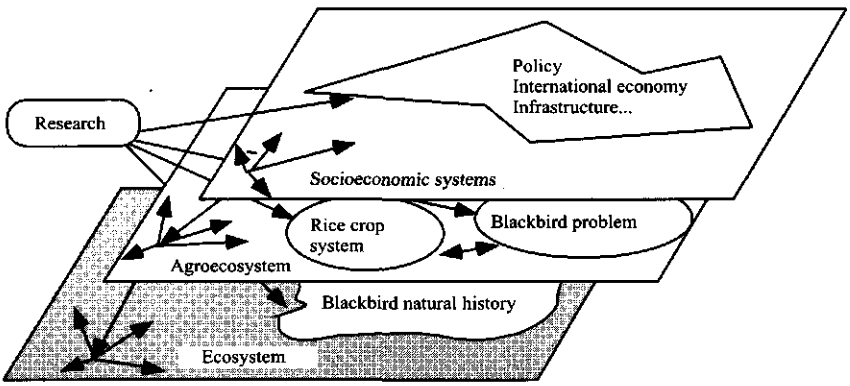
The process of modeling facilitates the organization of information and the interpretation of opinions and observations gathered during the research process, it indicates trends, can suggest different options to attack the problem, but can never predict final results. The models, when discussed with the actors should supply, together with other techniques, the stimulus for debate and reflection, or even examine the possible consequences of the proposals presented, aiming at the implementation of a management program for *A. ruficapillus*.

5.2.8. Identification of the causes of the population increase of the Blackbird (*A. ruficapillus*) in the Southern region of Rio Grande do Sul, Brazil[19]

The increase in the blackbird (*A. ruficapillus*) population can be considered a manifestation of an environmental imbalance. The identification of its causes could indicate the choice of procedures necessary to reduce its population to a level that would not economically jeopardize rice production or cause environmental damage as well.

During the exploratory stage of this research, the origin of the problem was searched for, not only in the agroecosystem, but also in the natural and socioeconomic systems (Figure 28). Through interviews and workshops with people related to the rice production sector in the region of Rio Grande and Santa Vitória do Palmar in Rio Grande do Sul State, variables were chosen and studied which were presumed to have importance as causal factors.

Figure 28. *Hierarchical structure of the three interaction levels of the population increase of A. ruficapillus in Rio Grande do Sul, Brazil – EMBRAPA/CPACT 1997.*



A cause-effect model (Diagram 2) was built to identify the possible causes for the increase in the blackbird population. The construction of the model began with the dependent variable at the top, successively unfolding the factors that were presumed to play a causal role. The causes were not independent or static but rather interrelated and dynamic, inducing more than one effect and acting continuously during a certain period of time.

[19] Silva, J. J. C.[1]; Cirne, M.P.[2]; Franco, D. F.[1]; Asmus, M. L.[3]; Echeverria, A.[2]

[1] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS, Brazil

[2] UCPel, caixa postal 402, CEP 96100, Pelotas-RS, Brazil

[3] Dept° de Oceanografia - FURG, caixa postal 474, CEP 96201-900, Rio Grande-RS, Brazil

The analysis of the diagram showed that the increase in the food availability during winter could be considered the main cause in the abnormal increase of the blackbird population. The normal food supply reduction during winter causes a synchronization [a reduction] in the reproduction period, since the development of the young has to coincide with the food supply in order to avoid the natural mortality caused by starvation and/or sickness. The elimination of this inhibitor – food supply reduction during winter – stimulates the female both to lengthen and intensify the reproductive period. This increase of food availability during winter is caused by rice losses along the roads during the transportation of the harvest to the cities, by rice grains and weed seeds found in the residue of the rice harvest usually left near the processing units of rural properties, and by rice losses during harvest.

These losses are consequences of the changes in the technological level of the rice production. Due to socioeconomic reasons influenced by national development politics, all rice has been harvested by combine since 1975. Before the advent of combines, rice was cut with a scythe, arranged in shocks by hand, allowed to dry for 2 to 6 weeks in the shock, and then threshed and carted to the mill. Rice is now cut and threshed in the field in one operation and then transported by truck to an artificial drier where its moisture content is gradually reduced within a few days. The dried or rough rice is stored in bulk at a grain silo or warehouse, and then from time to time is delivered to a mill for final market processing. There are many problems associated with the modern mechanized harvesting system. It is inefficient, both in terms of wastage and harvesting often takes place when the grain is not at the optimal percentage of humidity. There are problems of adjustment with the combine itself and it is not conservation friendly. More importantly, especially as far as this research concerned, it provides more opportunity for grain loss, thus increasing the Blackbird food supply.

Based on field work, analysis of models and on information provided by farmers in Rio Grande do Sul (Table 19), it can be concluded that the Blackbird population began to increase approximately 5 years after changes in the technological level of rice production.

Table 19. *Some factors related to the Blackbird problem, according to three groups of rice farmers in Rio Grande do Sul. EMBRAPA-ETB/CPACT, Pelotas, 1997.*

	Rio Pardo Cooperative	Pelotas CITE 55	Rio Grande CITE 01
Introduction of rice crop	1950	1930	1930
Introduction of bulk harvesting	1986	1978	1975
Introduction of rice processing at rural properties	1986	1980	1975
Identification of Blackbird eating rice on roads	1988	1984	1978
Indentification of Blackbird as a rice pest	1991	1984	1982
Years after introduction of rice processing at rural properties that Blackbird became considered pest	5	4	7

The cause-effect diagram (Diagram 2) must be seen as a causal chain, chronologically organized. Connections and relationships among factors concerning the Blackbird problem are highlighted. It can be seen that the cause of the problem is not only at the rural property production level but goes right back to the socio-economic and political issues of the country.

Therefore, the cause-effect model provides a framework for analyzing the dimensions of the situation, facilitates the identification of possible solutions, and guides the decision making process for the most appropriate strategy for solving the problem. If one decides to use a strategy that intervenes at a point too high on the diagram, too many underlying causes remain unresolved and prevent a sustainable solution. On the other hand, treating a problem at its roots usually results in resolving the higher order symptoms in the long term (Fussell, 1995). However, in some cases it would not be feasible to intervene beyond a certain point; for example, in a situation where basic structural aspects would have to be changed (Beghin and Dujardin, 1988). This point is investigated further in the next chapter of this thesis.

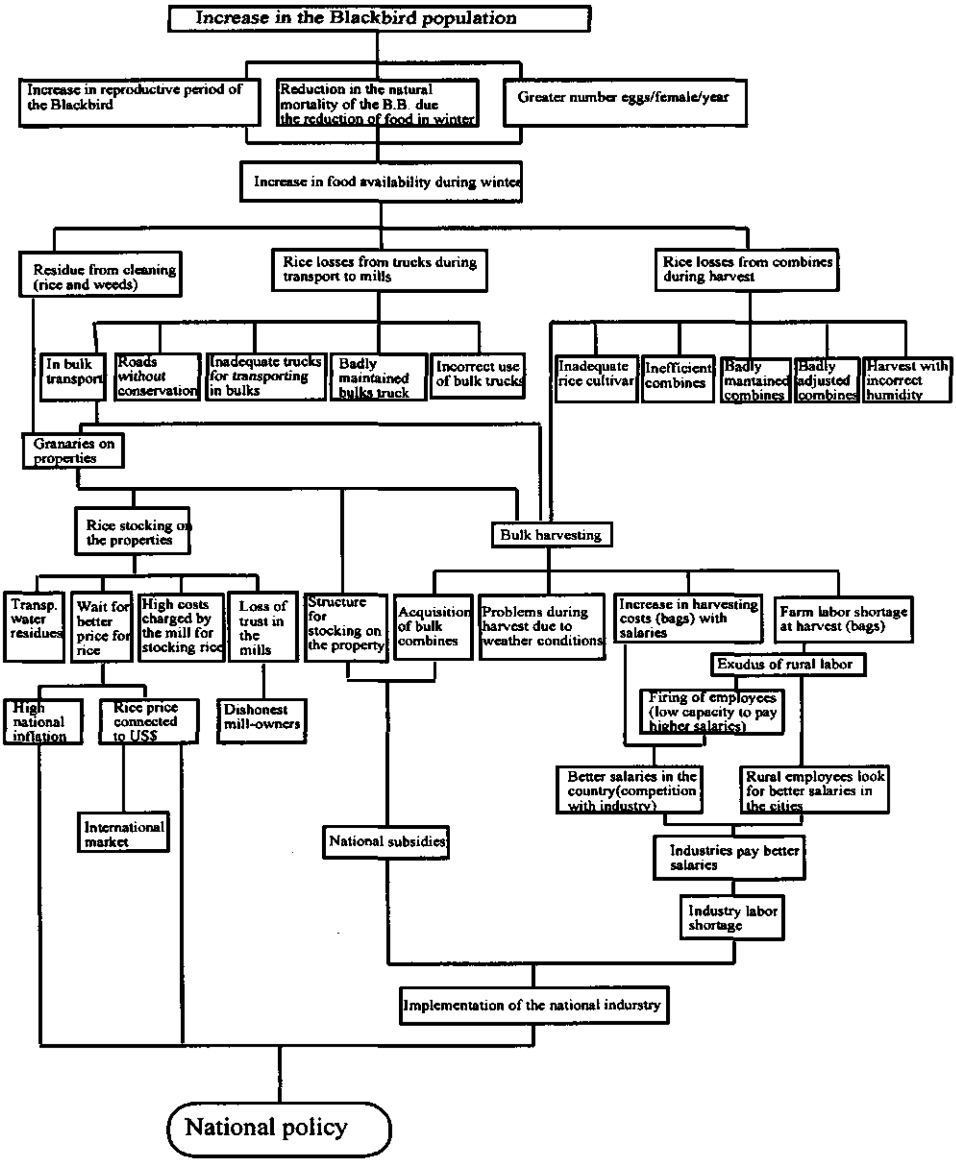
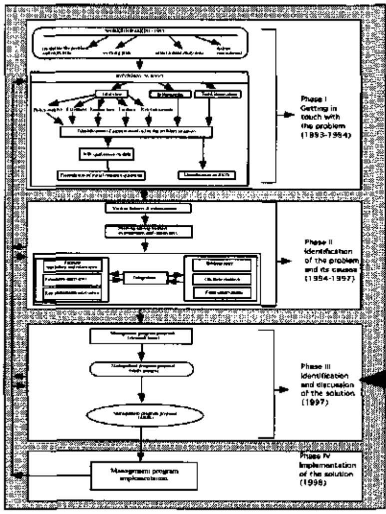


Diagram 2. *Cause-effect model of the population increase of A. ruficapillus in Rio Grande do Sul – EMBRAPA-ETB/CPACT, Pelotas, Brazil, 1997*

6. IDENTIFICATION AND DISCUSSION OF THE SOLUTION

6.1. Introduction

6.2. Blackbird management program in the irrigated rice crop of Southern Rio Grande do Sul



6.1. Introduction

Results from phase I (Chapter 4) and phase 2 (Chapter 5) indicated that changing farm management may provide a solution to Blackbird over-population. According to Vereijken (1992) and Engel (1997), any design for improving farm structure or farm management should be accepted by all regional stakeholders. This must be prepared professionally.

First, the project team[20], along with some representatives form the CITE study group of rice farmers in the Mirim Lagoon region, started by designing a theoretical management program. Subsequently, our theoretical plan had to be presented to other study groups in the region. This meeting was organized as the "First Meeting on the Blackbird and its interaction with the rice culture in the MERCOSUL countries" (MBRM).

The meeting in Pelotas, Brazil, was attended by representatives from Brazil, Uruguay and Argentina. Not only rice farmers attended the meeting, but also researchers, environmentalists and nature conservationists. Their feedback helped to construct a theoretical plan that practical people in the region could work with. The improved theoretical management plan became a real proposal and ready for implementation, after acceptance by all regional stakeholders identified in our agricultural knowledge information system (chapter 4).

---

[20] Silva, J. J. C.[1]; Cirne, M.P.[2]; Franco, D.[1]; Asmus,. M. L.[3]; Vieira,.M.[2] & Portantiolo; C. D. R.[2]

[1] EMBRAPA-CPACT, caixa postal 403, CEP 96001-970, Pelotas-RS

[2] UCPel, caixa postal 402, CEP 96100, Pelotas-RS

[3] Deptº de Oceanografia - FURG, caixa postal 474, CEP 96201-900, Rio Grande-RS;

Note. This theoretical management program is part of the project Nº 04.094.443.15 — The importance of Blackbirds to irrigated rice, under coordination of Silva, J. J. C. da (Researcher of the agricultural research center for the temperate climate region, Brazil).

Our final management plan for controlling Blackbird problems at rice farm level, had to be formulated in such a way that stakeholders felt themselves addressed by commitment, motivations, strategies and shared feelings concerning constraints and views on environmental protection. Therefore, the project team tried to formulate recommendations in a non-conflicting way. One recommendation had to support the other. Apart from our recommendations, the management plan had to induce the research agenda of scientific institutes to become more Blackbird problem oriented.

Total eradication of the Blackbird population has never been considered a desirable option. The pan was to keep Blackbird populations below their economical damage thresholds. Blackbirds do also have a useful function for rice farmers in that they eat vast quantities of harmful insects and seeds of many noxious weeds throughout the year (Meanley, 1971; Green, 1973; Haag et al., 1987; Fallavena, 1988; Wiley and Wiley, 1980; Rodríguez et al., 1995; Rodríguez et al., 1996; Franco et al., 1997). Somewhere, our management plan had to find a balance between fighting against serious depressions in harvests and benefits for sustainable crop protection.

A management plan for regulation of Blackbird populations in rice is a long-term solution. The practical application of the solution needs sophisticated forms of extension. The plan does not reduce population numbers immediately and therefore the farmer has to be patient and live with the problem for some time. As soon as the farmer sees a reduction in the amount of damage, the more inclined he will be to adopt a greater number of our recommendations.

The following paragraph present our results in three sections (a complet overview of recommendations is presented on table 20 at the end of this chapter):

- ✓ actions to support removal of the cause of the Blackbird overpopulation;
- ✓ actions to reduce damage from the Blackbird during the rice sowing period and
- ✓ actions to reduce damage from the Blackbird during the rice maturation period.

6.2. Management program for controlling the Blackbird in the irrigated rice crops of Southern Rio Grande do Sul

It is my hope that the actions here presented can solve the problem with the Blackbird in a permanent way. They might be considered as "source oriented" solutions. Such solutions will prevent abnormal and sudden increases of bird populations. The actions concerned are regional oriented. Therefore, it is essential that all regional farmers adopt them as much as possible. The solutions will be less effective the less farmers implement the recommendations. Actions were to be taken as follows:

- ➤ *Actions to support removal of the cause of the Blackbird overpopulation*
  - ✓ reduction of losses during harvesting
  - ✓ reduction of rice residues in waste heaps after pre-cleaning
  - ✓ reduction of rice lost during transport to the mills
  - ✓ accept hunting and trapping
  - ✓
- ➤ *Actions to reduce damage from Blackbird during the rice sowing period*
  - ✓ general agronomical recommendations
    - create a good initial stand;
    - thoroughly cover seeds after sowing, ;
    - increase seed density while sowing;
    - make seeds unattractive by natural repellants;
    - application of seed coating;
    - Synchronize sowing dates at various farms;
    - deep sowing; and

  - increase sowing density at 200 meters from the border of wood and swamps.
- ✓ pre-germinated
  - do not sow pre-germinated seeds close to swamps and woods, but quite far from there;
  - increase sowing density within 200 meters from swamps and woods;
  - do not remove all irrigation water after sowing;
- ✓ broadcast sowing
  - *cover seeds immediately after sowing and*
  - improve harrowing operation to make them more efficient in covering seeds after sowing.
- ✓ no-tillage
  - improve soil compacting system to cover seeds completely
  - increase the "covering" (dead plants) in the no-tillage sowing system
  -

➢ ***Actions to reduce damage from Blackbirds during the rice maturation period.***

- ✓ breed rice varieties with some special characteristics (grain size, flag leave, grain taste, grain roughness, grain palatability, greater resistance of natural degraining, better-husked grains, strong rice-stalks);
- ✓ do not grow rice within 200 m from woods and swamps;
- ✓ first sowing should be done far from woods and swamps;
- ✓ maintain rice fields and its edges without weeds;
- ✓ create an "alternative" natural food resource for Blackbirds;
- ✓ drain rice fields as early as possible and
- ✓ harvest rice as soon as the moisture content in the grain is appropriate.

The following paragraphs detail each of the recommendations just mentioned.

6.2.1. Actions to support removal of the cause of the Blackbirds problem in rice

Blackbirds need, like any other bird, protein-carbohydrates especially for their reproduction. *Quelea quelea*, being their normal diet, contain sufficient carbohydrates for energy, but lacks sufficient proteins for their growth and development (Jones and Ward, 1976). Some seed-consuming birds therefore switched over to eating of insects. Insects are rich in protein contents (65 - 70 % dry matter weight), thus compensating their need for proteins. *Quelea quelea* only grows during rainy months, when insects are abundant. Therefore, protein compensation by eating insects is possible only during the wet season (Avery, 1977).

Nestlings are birds, just hatched from their eggs. Their growth and development need quit a lot of proteins, so parents used to bring insects instead of seeds. However, Avery (1977) reports that nestlings of the Sharp-tailed Munia (*Lonchura striata*) are fed with rice seeds in their milky stage. As soon as these birds have left their nests, they need more carbohydrates than proteins. The Sharp-tailed Munia could therefore be considered as a pest in rice production.

To avoid starvation, birds have evolved a behaviour that helps them to survive during periods of food scarcity. Food shortage occurs outside the rice production season, but might also happen when their population density is too high. Avery (1977; 1980) suggest that *Lonchura striata* have harmonised their reproduction cycle upon the production cycle of rice. Butler (1899; cited by Avery, 1977), says that bird adults prevent the egg hatching until rice crops are ripe. His hypothesis, based on many observations, says that their nesting period is synchronized with moments of abundant supplies of food, not with the season of the year. This hypothesis might be supported by other observations. Avery (1980) determined that growth and development of *Lonchura striata* is very much synchronized with manmade cycles of rice cultivation. The bird simply lost its natural production cycle related with rainy seasons and the consequent abundance of insects. Avery (1982) found that nest building activities by *Lonchura striata* is correlated by irrigation schedules, applied by rice producing farmers. A correlation with rainy seasons is weak. This is in line with observations done on *Cisticola juncidis* a bird in rice farms of Malaysia. In Malaysia rice production cycles are not synchronized. Therefore, sufficient food for the birds is supplied year-round.

According to scientists from EMBRAPA (EMBRAPA-CPACT, 1993), winter crops are not grown in the rice production areas of the Southern part of Rio Grande do Sul. Consequently, farming do not cause an increase in insect populations during this time. Therefore, we can assume that the protein supply for Blackbirds is not connected with food cropping. So, the abnormal increase of *A. ruficapillus* must be a consequence of another food source. We found many examples of food sources outside the farms themselves during the winter. From literature, we understood that *A. ruficapillus* suffers from starvation during this period but when given sufficient carbohydrates can maintain its body temperature and survive the winter. Rice residues on roads, stocks, waste heaps near mills and farms, are available for birds during wintertime and this has resulted in the abnormal and gradual increase of *A. ruficapillus*. (Silva et al., 1997c) presumes a strong correlation with present procedures concerning after harvest handling of rice. Indeed, we found that harvesting methods at farms, transport methods, quality of trucks, storage and refinery methods and waste treatment of rice, produce sufficient losses to become abundant food supply for *A. ruficapillus* during wintertime. Losses seemed to be so big that even poor people have food collection from roads. Our hypothesis points at improvement of all post harvest procedures.

To improve the way rice is handled and managed after harvesting demands a financial investment and commitment. This will not happen unless stakeholders are convinced concerning the correlation between abundant food supply during winter and the abnormal rise in the Blackbird population. Firstly, we presented [based on literature] the amount of food which a Blackbird might required during the winter season, thus making it obvious that *A. ruficapillus* indeed obtained sufficient food from rice losses [and residues] left during the winter. Avery (1977) made a very useful analysis (based on literature) and calculated the amount of food which one bird needs per animal per season. (Juliano, 1963) states that the energy content of one rice grain is about 4.1 kcal/g. According to (Jones and Ward, 1976) this is 300 cal/g higher than that of wild grasses like *Panicum, Setaria and Pennisetum*. So, on a per gram basis, there is a slight energy advantage for the consumption of rice instead of seeds of wild grasses. According to Aviola et al. (1973), a munia consumes about 3 grams of rice per day, under caged conditions. We accept that *A. ruficapillus* needs 12,3 kcal per day. This number is quite a conservative estimation compared with birds under full field conditions. *A. ruficapillus* can obtain the required energy from 120 rice grains per day [assuming a rice dry weigh of 26 g/1000 grains].

Our hypothesis that food reduction would result in reduction of the laying season (Butler, 1899; cited by Avery, 1977) and consequently in a decrease in Blackbird population was presented to the stakeholders. It was assumed that re-adaptation of the birds' behaviour would happen along the following model:

Food reduction→ increase death rate→ reduction of laying season→ population original level

So, our management program should be based on three main actions in order to reduce food supply during the winter time. The proposed actions are:

- ✓ reduction of losses of rice during harvesting;
- ✓ reduction of rice residues in waste heaps after pre-cleaning;
- ✓ reduction of rice lost during transport to the mills and
- ✓ [additionally] accept hunting and trapping

Reduction of losses during harvesting

Meanley (1971) and Bucher & Bedano (1976) showed that a considerable amount of grains are left on the ground after harvesting. The birds have to prepare themselves for the winter ahead by feeding well. The grains from the harvested fields can support them during the time between harvesting and the transporting of rice. Despite the fact that we did not observe large flocks of blackbirds feeding on rice stubble at the end of winter — probably due to decomposition of seeds by weather — there is no doubt that reduction of supplies directly after harvesting should be pursued.

Losses that occur during the harvesting period are related to the moment of harvest, adjustments of combine harvester, inefficiency of combine harvester, natural rice degrainulation and excessive loads during rice transportation from fields to warehouse (Basler, 1993; Alonço, 1997). Total losses vary from 3% (Basler, 1993; Reis et al., 1996) up to 12,6% (Reti, 1995; Weber, 1995). So, if one considers that Rio Grande do Sul produces approximately 4,6 million tons per year (Vieira and Rangel, 1984; EMBRAPA-CPACT, 1993; Vieira and Rangel, 1993; Azambuja et al., 1996), 12,6% of losses during harvest represents approximately 579,6 thousand tons per year as a potential food supply for Blackbirds — a similar conclusion was obtained by Kalmbach (1937; cited by Meanley, 1971).

To reduce losses during harvest, it is suggested that farmers should harvest their rice at an appropriate moment [weather conditions, grain moisture content], adjust their combines more accurately and avoid excessive loads during transportation of rice form field to warehouse. Special care should be taken when driving on bumpy rice fields or farm roads. As soon as the trucks are full, rice grains fall easily when wheels bump on their surface. Bumpy farm fields or roads are caused by too heavy equipment driven on weak soils. Wet rice production occurs on such soils.

However, a total reduction of losses during harvesting is not practically possible. Therefore, apart from recommendations above, farmers should plough rice stubble during the autumn or winter. This recommendation will help to cover weed and rice seeds, which will make them less easily available for the birds. Moreover, ploughing in autumn or winter favours weed control and quick decay of the stuble, inducing a better soil quality and an easy seed bed preparation in the spring.

Reduction of rice residues in waste heaps after pre-cleaning

Residues from the pre-cleaning processes in rice mills are currently deposited at waste heaps adjacent to a mill. Such heaps are visited by quite large numbers of Blackbirds. So it was assumed that they must have been finding find reasonable amounts of rice grains. The composition of the residue heaps was investigated and it was found that in general they contain 12,1 % of rice grains (whole and broken ones) and 1,1 % of grains from various weeds occurring in rice crops. Silva et al. (1997h) and Franco et al. (1997) found that exactly the same composition of grains could be found in the diets of *A. ruficapillus* — even during the wintertime. As waste heaps also contain large quantities of rice straw we concluded that decomposition takes a long time during the winter months.

According to Basler (1993), Franco et al. (1996) and IRGA (1980), waste represents about 3% of harvested rice. Considering that the waste contains 12,1% of rice (whole and broken grains) and 1,1% of other species it represents approximately 18,2 thousand tons per year. This is the potential food resource for the Blackbird during wintertime. In fact, this is only a small proportion from the total amount of losses during harvesting (about 580 thousand-ton per year). However, the 18,2 thousand tons of rice are openly available throughout the year and such places [displayed at one place inside the farm] can easily be visited by birds. Weak and exhausted birds will recover quickly at such waste heaps, as they do not need to spend much energy while searching for their food.

We suggest overcoming the problem by considering residues after pre-cleaning of rice not as a waste, but as a feed resource for chicken and cattle. CIENTEC (1998) recommends mixing rice residues with 1 to 3 % of ammonia. Ammonia should be added to rice residues packed in plastic bags which should then remain sealed for approximately 30 days. The product is then ready for use. With a mixture of 7 kg of rice residue and 3,5 kg of ammonia the treated rice residue is calculated to produce approximately 1 kg meat during the winter-time. This recommendation seems to be profitable for the farmer and gives him the additional advantage of using the waste heaps productively and keeping his farm area clear of the potential food source for Blackbirds.

Reduction of rice lost during transport to the mills

We found large numbers of foraging birds on the roads to the rice mills. Flocks were abundant during autumn and winter, when production of seed by wild plants is scarce. We know by now that lost rice grains are responsible for that. Silva et al (1997i) states that rice grains are lost for several reasons. There are often holes in the bodies of the trucks, carriers are unsuitable for the rice transport, the roads are bumpy and in poor conditions and finally, the load of rice often excessive and uncovered. We found that about 0,16 % of rice grains per ton per hundred km was lost in each transport. One can conclude from this that a minimum of 26 kg per km per day of rice is lost. As Rio Grande do Sul produces about 4,6 million tons of rice per year (Azambuja et al., 1996; EMBRAPA-CPACT, 1993; Vieira and Rangel, 1993; Vieira and Rangel, 1984), then 0,16 % of that represents 7,4 thousand tons of rice lost per year to the Blackbirds.

Although this loss is small compared to losses during harvesting (579,6 thousand tons per year) and pre-cleaning procedures (18,2 thousand tons per year) it is a readily available and regular food source with farmers sending their rice to the mills once a month.

The recommendations given to reduce rice losses during transportation to mills are quite obvious: holes in bodytrucks should be filled and trucks suitable for rice transport should be used. Also, the loads should me smaller and covered.

However, farmers complain that during the rice harvesting period, good trucks are difficult to rent for reasonable prices. Truck drivers get better prices for transporting soybean, which happens during the same period. Despite these difficulties, the recommendations could still be implemented during the winter when trucks are cheaper and the effect on reducing the Blackbird population will achieve better results because of a shortage of food at that time.

Accept hunting and trapping

Our simulation studies suggested that a Blackbird population starts to increase about seven years after food availability during winter (Silva et al., 1997a). We also found that once a Blackbird population had been established at damage causing levels, it will take about 15 years before the birds returns at its original level, after implementation of the above recommendations. Farmers felt that 15 years was too long a period to wait. Their economic situation in relation to quick depreciation of their technical equipment made them sceptical about the results from the various scenarios produced by our simulation studies. Scepticism could result in poor implementation of our recommendations. Therefore, we had to find quicker ways to reduce the number of Blackbirds.

Farmers suggested to sophisticate their hunting and trapping techniques. They experienced both methods to be successful and this has been supported by experiences elsewhere (Meanley, 1971; Costa, 1950; Flores and Nassif, 1993). Combined with methods which help to make birds scared, farmers found that population densities can be reduced considerably. Just scaring them away with the help of explosions produced by special blasters, appears not to be reliable. Birds adapt quickly and finally ignore the noise. However, when explosions are associated with mortality, birds start to stay away (Helton, 1995). Meanley (1971) and Texas Agricultural Extension Service (1997) advises that the birds need to be scared off from the fields as soon as they start to forage. The longer the delay, the sooner adaptation occurs.

Trapping of Blackbirds seems to have various results. Success is dependent on many factors: e.g. type of traps, size and site of traps, the number of birds present on the farm, season of the year, baits, abundance and kind of food available for birds adjacent to trap sites and know-how of the farmer (Meanley, 1971). Further field experiments are needed for refining this recommendation.

Considering the farmers' experiences together with the results from our study, farmers decided to apply formally for hunting licenses. As Blackbirds were protected animals, hunting was illegal. Farmers decided to apply formally at the end of the MBRM conference (see page 70). They requested IBAMA (Brazilian Institute for the Environment) to legalize hunting and trapping of Blackbird. Based on our studies, facts and data (Meanley, 1971; Costa, 1950; Flores and Nassif, 1993), the Brazilian Institute for the Environment (IBAMA) published in 26.05.98 the edict 63-N. The edict considered *A. ruficapillus* a pest affecting rice production and include aspects related to hunting and trapping.

Farmers have to understand that these population reduction methods are complementary methods within a management program. They must be advised that the birds that killed will soon be replaced, and the population reduction methods will have to be repeated.

Finally, it must be highlighted that both methods if applied by personnel without skills in relation to determination of species and legislation may result in indiscriminate killing of birds. Both, farmers and agencies involved with wildlife damage management must increase their skills accordingly.

6.2.2. Actions to reduce damage from Blackbirds during the rice sowing period

While farmers may not be successful in reducing Blackbird population densities to their original levels, certain actions can be taken during the rice sowing period to relieve the problem a little. As summarized on pages 71 and 72, they can be categorized in four main sections:

General agronomical recommendations

Observations done during our study (Silva et al., 1997f) revealed that many farmers start production with poor ***initial stands***, much below of the 300 seedlings per m^2 as recommended by experimental field stations (Infeld et al., 1996). We observed that such poor initial stands do not produce good yields. Especially, when such stands are also damaged by Blackbirds. It is recommended to farmers that they follow the official recommendations strictly. Seed density, seed quality, soil tilling, adjustment of equipment and a correct sowing time are relevant criteria for getting good initial stands.

According to Helton (1995) and Texas Agricultural Extension Service (1997) and asserted by our own observations during this study, farmers were advised to ***cover seeds*** after sowing as much as possible. Covered seed is harder for the birds to find.

This study proved that rice crops are heavily attacked if they are located up to 200 meters from woods and swamps. The first and last sown crops being the most sensitive to Blackbird damage (Flores and Nassif, 1993; Silva et al., 1997f). Some farmers in Southern Brazil used to increase the ***density of sowing*** near such sites, in order to overcome the problem. Helton (1995) and Texas Agricultural Extension Service (1997) also advise farmers to do so. However, from our studies we also found damage caused by the high density of plants. Lodging occurs when plants are competing for light or when panicles are too heavy because of a high nitrate uptake from well-manured soils. Lodging might severely enhance damage by Blackbirds. This might explain why crops close to woods and swamps seem to be damaged by Blackbirds in a more serious way. Further research concerning the optimal point between sowing density and damage by lodging, should be carried out preferably in co-operation with farmers. Their experiences could be discussed within the CITE study groups.

Many farmers and researchers accept that ***rice seeds coated with natural repellants***, make grains unpalatable to Blackbirds (Helton, 1995). Repellents do not to kill birds, but cause severe nausea. The birds not want to return to eat at the same site again. Conditioned food-avoidance learning has been demonstrated in numerous animal species (Barker et al. 1977; Avery et al., 1993; Avery et al., 1994). One family of compounds, the pyrazines, is particular widespread in nature. It has been proved that the smells of such compounds have a warning function (Avery and Nelms, 1990). Guilford et al. (1987) conditioned a one week-old domestic chick (*Gallus gallus*) to avoid quinine-treated water paired with 2-methyl-3-isobutylpyrazine. Avery and Decker (1992) working with *Agelaius phoeniceus* concluded that while ethyl cinnamate was a moderate deterrent, consumption of treated rice was virtually eliminated by a 1.0% (g/g) application of methyl cinnamate. Gill et al. (1994) concluded that cinnamamide significantly reduced food consumption by *A. ruficapillus* during two choice and 'short-term no choice' tests.

Theoretically, after experiencing the effect of rice treated with repellents, the birds should not return. This kind of learning could be transferred from adults to their young or from experienced adults to young adults. Once the initial conditioning is accomplished, only occasional treatments would be necessary to reinforce the new behaviour. However, no seed repellent is completely effective (Helton, 1995). According to Avery (1994), information transfer through social interactions within the flock affect foraging decisions at some levels but not at others. Initially, birds must decide where to search for food. Birds making such basic decisions can find food more quickly by following experienced, knowledgeable roostmates (Ward and Zahavi 1973; Pöysä, 1992). Avery (1994) states that the benefit of associating with experienced birds was in learning where to forage, not where to avoid food. Finally, according to Avery et al. (1995), it is suggested that one of the principals factors influencing the effectiveness of the rice seed repellents is the type and availability of alternative food sources. Red-winged blackbirds (*Agelaius phoeniceus*) may not be deterred by seed treatment if newly sown rice is all that is available. Presently, no chemical repellents are registered in Brazil for blackbirds in rice. It was suggested that this be brought to the attention of the research institutions to evaluate the viability of repellents to reduce damage to seedling rice. Repellents can be recommended in Brazil if they are shown to be efficient and free from eco-toxicological problems.

Daneke and Decker (1988) introduced a method that influences foraging behavior of *Agelaius phoeniceus*. They found that birds that have difficulty in swallowing their food need more time for forage. ***Coating seed*** with a substance which becomes sticky after wetting in soils or crops inhibits foraging by birds, because sticky seed grains inhibit movement of their bills, thus slowing down the number of grains to be swallowed when foraging. Decker and Avery (1990) suggest that birds will then search for alternatives outside the crop. Results from Daneke and Decker (1988) and Decker and Avery (1990) are most promising. We do not know however, if this holds true for *A. ruficapillus* as well, especially in the case of large crops treated with coated seed. Moreover, we have to expect certain effects on profitability of rice production as well. Further professional research is necessary.

Haven (1971) and Meanley (1971) showed clearly that damage from *A. ruficapillus* is most severe in the first fields to contain rice grain and also in the last fields to be harvested. Our field observations fully support these results and it is recommended that farmers must try to practice ***uniformity in sowing dates.***

At the MBRM conference it was felt that Blackbird damage might be reduced if seed is sown much deeper than the two cm depth farmers are used to. According to Infield et al. (1996), for conventional and no-tillage farming systems a five cm depth has been advised. Seeds, laid down at deeper layers might be difficult to find by Blackbird. Our farmers showed a reluctance in doing this fearing that seed at a five cm deep might result in a bad stand due to low seed vigor. They also feared crustation of the topsoil, due to quick evaporation under strong sunny circumstances after raining, thus inhibiting regular germination. Further professional research is necessary.

The most intensive attack by blackbirds to rice occurs on crops located up to 200 meters from woods and swamps and as already mentioned on first and last sowed crops. There, re-sowing is often needed (Flores and Nassif, 1993; Silva et al., 1997f). Woods and swamps are important shelter and nesting sites for *A. ruficapillus.* These sites also function as "springboards" towards rice fields (Meanley, 1971; Rutger, 1990). According to our observations (Silva et al., 1997f), flocks fly in constant "to and fro" patterns, between crops and nesting sites. Farmers in Southern Brazil used to ***increase the density of sowing*** to overcome this problem. Similar action is recommended by Helton (1995) and Texas Agricultural Extension Service (1997) to deal with this problem. However, during the MBRM, researchers pointed to some problems that could emerge due this practice such as plants being "bedridden" (the plant grows too much and falls) and a greater incidence of diseases. Due to their concern, a suggestion to study this question was forwarded to the research institutions. Meanwhile research does not provide a conclusion about this subject, and it is left to the discretion of the farmer. It has been suggested that at least initially, each farmer should perform preliminary tests in a small part of his crop. Also, it is suggested that production within 200 meters from woods and swamps be avoided.

Pre-germinated

The pre-germination of rice seed became a very popular farming system in Rio Grande do Sul. Pre-germination, compared with other systems, is a low cost method and gives good results even under adverse climate conditions. The area with pre-germinated systems in Rio Grande do Sul is at present about 33.280 ha. This is only 4.2 % of the total rice area. The amount of acreage increases every year. From 1993 to 1996 the area with pre-germinated systems increased by 226%. Last year that area increased to 54 % (Tronchoni et al., 1997). Considering farmers' interest for pre-germination systems, we had to pay attention to damage caused by the Blackbirds. According to farmers' experiences, they reported serious cases of damage. They now think that pre-germination is probably the most vulnerable to Blackbird damage.

Our research however did not support their conclusion. Compared with other production systems, under various sites and moments of sowing, we found that for the first crops of the season the damage by the blackbird on pre-germinate systems was intense. A pre-germinated system is the first, and the only one sowed under adverse climate conditions. This is quite similar with American rice growers, applying pre-germinated farming systems (Flores and Nassif, 1993). Pre-germinated seed is the first available food source after the winter period so it is natural that Blackbird will eat it. Also, the pre-germination systems are more popular near woods and swamps. Farmers do so because their roads and irrigation equipment start close to these sites.

This study clearly showed that such sites are visited by the Blackbirds first indicating that the moment of sowing, combined with the site where pre-germination happens, results in heavy damage by Blackbirds in pre-germinated sowing systems. The birds do not seem to have a preference for pre-germinated seed. The following recommendations are given:

- ✓ ***It is recommended that pre-germinated seed is not sown close to swamps or woods;***
- ✓ ***Sowing density should be increased within 200 meters from swamps and wood; and finally***
- ✓ ***it is suggested to not remove all water after sowing.***

Concerning the latter advise, some additional remarks should be made.

It is recommended, if using pre-germinated seed, that the ground be covered with 5-10 cm of water for 15 days before sowing. After sowing the water should be removed in such a way that the soils are kept saturated. As soon as the plants grow, the water should be flowed in gradually up to a ten cm above the topsoil, until the rice matures. This controls weeds, especially the red rice (Gomes et al., 1996; Gomes and Petrini, 1996; Reunião da cultura do arroz irrigado, 1996).

Accepting the possibility that Blackbirds may be hampered by the presence of water, farmers started some on farm experiments. They were supported by reports on similar experiments by Flores and Nassif (1993), Helton (1995) and the TEXAS AGRICULTURAL EXTENSION SERVICE (1997). Their conclusion indicates that keeping water on fields just sown with pre-germinated seeds might damage the roots. Bad roots will result problems at the maturing phase. Heavy panicles will let stalks fall down easily, causing increased damage by Blackbirds during harvesting. Farmers are starting to look to rice breeding companies to develop varieties that are more adapted to pre-germination systems with undrained fields just after sowing. Further professional research is recommended.

Broadcast sowing

Most rice fields (80%) in Rio Grande do Sul are sown in lines or the seeds broadcasted. Both methods demand soil preparation like ploughing and harrowing before sowing (Reunião da cultura do arroz irrigado, 1996; Gomes et al., 1996). According to Zaffaroni et al. (1997), the percentage of conventional broadcast sowing occurs at 90 % of fields up to 50 ha and at 20 % of fields larger than 200 ha [the author did not included farmers with areas of 50-200 ha]. Broadcast sowing increases when climate conditions at the moment of sowing are unfavourable, e.g. when it rains.

We found that such a situation [broadcast sowing when climate conditions are bad] often meant that seed was exposed to birds for an undue length of time. Seeds remained uncovered between ploughing and harrowing due to shortage of equipment, deficiencies of equipment and adjustment. According to Rodriguez et al (1995), up to 4,5% of seeds remained exposed by the use of a broadcast sowing system. More attention needs to be given to this problem and the following recommendations were made:

- ✓ ***to cover the seeds immediately after sowing and***
- ✓ ***to improve the harrowing operation to make it more efficient in covering seeds after sowing.***

No-tillage

For no-tillage systems, it is also advised that the ***seeds be completely covered*** after sowing. Farmers put this advise into practice but experienced some trouble with the part of the equipment that covers seeds with soil in the no-tillage system. Further scientific research is needed to improve the ***soil compacting system.***

Farmers suggested that damage from Blackbirds ***in no-tillage sowing systems could become less if fields were covered with more mulsh.*** Gomes (1997) recommends a three ton coverage (of mulsh) per ha in soils with drainage problems. Ruedel (1995) recommends maintaining a five to six ton coverage per ha on soils that are well drained. Farmers and researchers tried to find out which amount of coverage would be advisable for farmers on different fields with no-tillage systems. They concluded that mulsh coverage in lowland areas might not be advisable however. Natural drainage of lowland soils is a problem — there is almost no percolation of water to deeper layers. Indeed Gomes (1997) reports that coverage of such soils might not be advisable, because soils would stay wet after rain or irrigation for a longer period. Water logged soil make access by equipment difficult and causes delays in sowing. Our team suggested institutions to investigate optimal coverage and soil condition.

6.2.3. Actions to reduce damage from Blackbirds during the rice maturation period.

The following recommendations are not problem source-oriented. The recommendations will only alleviate the problem, and will not reduce the ***A. ruficapillus*** population density

Breed rice varieties with some special characteristics

Plant breeding might play an important role in the reduction of damage caused by Blackbirds in low population densities. Some special characteristics of rice varieties might help to reduce consumption or at least make consumption by birds more difficult. Our study revealed some important characteristics of certain rice varieties that are in demand.

Grain size of rice varieties might be important for reduction of damage by Blackbirds. According to observations of Avery (1977) and Linscombe et al. (1990), Blackbird have been shown to have some preference for medium-grain varieties over long-grain ones. In Rio Grande do Sul most varieties are long-grain (Terres et al., 1996; Reunião da cultura do arroz irrigado, 21, 1996). However, due to the Asian market, medium-grain varieties are been tested for further production in Rio Grande do Sul. Before advising the adoption of medium-grain varieties for the region, we need to be sure that new varieties are Blackbird resistant, since premature introduction of new varieties not sufficiently tested could have enormous economic consequences.

A similar question concerns the correlation between Blackbird damage and phenotypes among various rice varieties. Farmers accept for example that the position of the ***flag leave*** at the rice-stalk is important. Varieties in which flag leaves hide their panicles more effectively are probably better protected against consumption by Blackbirds. According to Fukoshima (1997) and Kempf et al. (1997) differences in damage among various rice varieties vary from 35 % to 100 %. They state that these differences are due to more or less better "protected" panicles by flag leaves. According to Terres et al. (1996), most varieties grown in the Rio Grande do Sul State show to be of the "right" variety [flag leaves hide their panicles]. It can be seen that further research is needed before recommendations of other varieties, especially where the flag leaves do not hide the panicles.

New rice varieties might include less preferred grains concerning ***taste, roughness or palatability***. Farmers have the impression [from their experiences] that Blackbirds are quite critical concerning these characteristics. We advise precaution to strive for rice varieties changed from those points of view. A consequence might be complete rejection of such varieties by consumers and also by rice processing industries. The taste of rice is a very important selling point. Rice varieties with hard or rough characteristics are more abrasive and reduce machine lifetime causing a problem for industry. Considering that almost all rice consumers in Brazil will only accept white and clear polished (translucent) rice grains (Schiocchet and Machado, 1997; Guimarães et al., 1997), farmers should be very careful in demanding a change of rice grain characteristic in order to repel Blackbirds.

Careful observations of the behaviour of *A. ruficapillus* during grain picking, revealed that the birds shake the panicles intensively, knocking the grains off to the ground. These observations are supported by Green (1973) and Haven (1971), while observing other Blackbirds species. Grain knocked off to ground has been proved to be food for Blackbirds in the wintertime (Crase and Haven, 1978). Rodríguez et al. (1995) found that the amount of rice might be as much as 250 kg per ha. Present varieties are especially "designed" for mechanical harvesting by combine [i.e. grains should easily be knocked off, in order to facilitate the separation of grain from the panicle]. Present rice varieties are therefore easily damaged by Blackbirds.

New rice varieties, which are better resistant to Blackbirds, could be designed by improving the fixation of grains in the panicle. We observed that natural ***degraining*** becomes worse if Blackbirds cause seeds to fall out of the panicle. Birds sitting on the rice-stalk or even shaking panicles the proposed new varieties might prevent premature degraining. However, farmers are afraid that such new varieties might result in breeds that are difficult to thresh during combining. They therefore will accept new breeds only, when they prevent degraining by birds but can be managed effectively during mechanical harvesting.

Varieties resistant to natural degraining do exist in the past. However, farmers and researchers in Rio Grande do Sul State (personal communication) states that losses [at harvesting] with those varieties used to occur in back the machine, since grains did not "let go" of panicle. To overcome the problem, farmers requested breeders to make rice varieties where the grains are more easily detach from panicle. At that time [early 70's] Brazilian farmers did not notice losses [of new varieties] in front of their combine because they used to harvest when the rice fields were flooded [and therefore, they could not see losses]. They had no choice because machines were not powerful enough to work on muddy soils.

Today, farmers have at their disposal new machines, powerful enough to run over heavy, recently drained soils. Farmers can therefore see for the first time how much was lost during harvesting. About 85 % of all rice lost during harvesting happens in front of combines (Gentil, 1985). Old "fashioned" genotypes: varieties in which grains are better fixed on their panicles could be a solution to this problem. However it recall ***better designed combines***, that is to say combines which will reduce losses in back the machine. Farmers have requested breeders to make rice varieties which are fully tested during threshing procedures within newly designed combines. A co-designing of varieties and combines is proposed. This will not be easy, as industries also have their particular objectives concerning new designs of combines. Furthermore, large investments would have to be made by the agricultural industries to create separate production lines appropriate for making machines exclusively for rice. Most activities are at present soybean oriented. Rice in Rio Grande do Sul is produced on 0.9 million ha while soybean is produced on three million ha.

Rice breeders could pay more attention to rice ***varieties with better-husked grains***. Crase and Haven (1978) report that Blackbirds prefer small and medium sized grains, as long or large ones are difficult to peel by the bird. Cirne et al. (1997a) and Meanley (1971) observed that Blackbirds roll grains in their beak at first and peel them before swallowing. Thus, they reduce grain size, favoring swallowing. Better-husked varieties might be less attractive for Blackbirds. Damage will thus be reduced or birds might choose an alternative food.

Green (1973) and the TEXAS AGRICULTURAL EXTENSION SERVICE (1997) report that Blackbirds easily break rice stalks while landing and settling themselves in large flocks when rice is in its' maturation phase. This observation was supported by our own findings. Heavy panicles in combination with quite weak rice-stalks make them easy to break or crack by the birds. Cracked rice-stalks are difficult to combine as they fall under the harvesting level of combines. Broken rice-stalks fall even below the water surface. Such panicles are lost. Damage will thus be reduced if new varieties have ***strong rice-stalks***. Further scientific research is needed.

Do not grow rice within 200 meters from woods and swamps

According to our observations (Silva et al., 1997f), flocks are seen to fly in a constant "to and fro" pattern, between crops and nesting sites. Crops within a distance of about 200 meters are most affected. Therefore, it is recommended to avoid [when possible], location of rice fields on such sites.

First sowing should be done far from woods and swamps

Our study revealed that farmers prefer to start sowing close to their roads. Roads are usually situated near edges of their fields [often near swamps or woods]. Farmers initially objected to the recommendation given concerning their first crops. Sometimes it is not possible to discard areas near to swamps and woods and also, it is useful to prepare machinery (adjustments, lubrication, fixing tools) and have lunch breaks in the shade. Woods meet these requirement perfectly. This is a clear example of unconscious interrelation between human behaviour and exacerbation of the Blackbird problem.

As an alternative option, farmers and rural workers decided to maintain their base in the shade but to begin far as possible from swamps and woods and in the middle of sowing season. By proceeding like this, it is foreseen that rice areas will be established in November and harvested in April. During both periods, there is sufficient natural food for the Blackbirds. Therefore, pressure on rice fields could be reduced. Research will be necessary to confirm our assumption.

Maintain rice fields and its edges without weeds

Studies, observations and information from farmers involved, revealed that Blackbirds prefer to eat small seeds of wild vegetation, mostly those that are regarded as weeds amongst rice crops. This has been supported by Franco et al. (1997). Manuel (1934, cited by Avery, 1977) state that *Lonchura malacca* clearly prefer to eat wild grasses in stead of rice, under field as well as under caged conditions. Wiley and Wiley (1980) never observed Blackbirds (*Agelaius icterocephalus*) in Surinam and Trinidad eating grains from cultivated rice. They state that foraging happens on ploughed land and fields lying fallow and in vegetation emerging from ditches and marshes. In Venezuela, they reported, Blackbirds especially males, used to feed themselves from wild rice (*Oriza perennis*).

Haven (1971), Meanley (1971), Rodríguez et al., (1995) and Helton (1995) raised the hypothesis that by eliminating the weeds near or within rice crops, the number of birds found inside the corps may be reduce. They also accepted that wild vegetation near or within rice crops, offers shelter and nesting sites to birds. From our study we indeed saw that birds, sheltering in wild vegetation at or near rice crops, started to damage rice fields as soon as the wild vegetation no longer met their nutritional demands. Where they have to fly from greater distances to the rice crops, the steam roller flight pattern they adopt (mainly to protect themselves from predators such as falcons) forces birds to diffuse over greater areas, thus causing less damage per unit of area.

Total weed destruction in or near rice fields is not widely accepted by nature conservationists. Meanley (1971) states that clean field margins or cleansed fences will mean a drastic reduction in habitats for a variety of wild life. According to Altieri (1995), an equilibrium of the crop fauna can be established by organizing vegetational diversity within and around the target crop fields. Providing the right kind of plant diversity throughout the year and manipulating time of planting, size of fields, and species compositions of crop fields border can make habitats and food resources continually available to populations of beneficial arthropods and make habitats less favorable for pests. Due to the circumstances, we recommend to maintain rice fields and its edges without weeds. However, intensive research is necessary to identify the possible consequences of such recommendation to the wild life in the area

Create an "alternative" natural food resources for Blackbirds

Study groups launched some ideas concerning efforts to lure birds away from the rice fields. The production of some crops in a field adjacent to a particular rice field might function as a trap. Trap crops may include rice which sprouts or matures earlier than surrounding rice fields produced for the market (Rutger, 1990).

Another idea was raised on the findings of Rutger (1990) and Rodríguez et al. (1995). Once birds start to nest at a certain site, they consider such a place as their most favored habitat and will stay as close to it as possible. Wiley and Wiley (1980) found that males held territories in large freshwater marsh far away (1 to 4 km) from rice fields. Also, they found birds only fly far away from marshes if the preferred food sources (wild grasses) can not be found in abundance. Wiley and Wiley (1980) found that female birds prefer to forage at 50 to 500 meters from their colony during summer and early fall. Males forage 25 - 100 meters from their nesting sites. According to Meanley (1971), blackbirds can fly as far as 25 to 30 miles if food can not be found near their roosts.

If farmers could provide the birds with sufficient food close to their original habitat, they might be able to keep the birds close to those sites, by removing the need to find food in the rice fields. We therefore suggest creating native pastures in areas far from rice production fields and close to the birds habitats. If native pastures are managed to produce all sorts of wild grass seeds, one might serve food resources for *A. ruficapillus* from September to

March, the sowing period and from March to May, being the harvest period. Field research will be necessary to confirm this hypothesis.

Drain rice fields as early as possible

Meanley (1971), Fallavena (1988) and Cirne et al. (1997a) states that Blackbirds roost over water within rice fields. Rice fields with large number of roost are very sensitive to Blackbird damage. Farmers concluded from our studies that experiments should be done in order to find out the effect of early drainage of rice fields on depriving birds from suitable habitats.

Harvest rice as soon as the moisture content in the grain is appropriate

Texas Agricultural Extension Service (1997) recommends that the rice is harvested as soon as the moisture content of the rice seeds is appropriate. There is a strong correlation between damage by Blackbirds and the duration of mature [due shortage of combines or unfavorable weather]rice on the fields.

Table 20. *List of action advised by the management program in order to control the Blackbird problem in rice production and indications of which group of actors can most appropriately carry out these actions.*

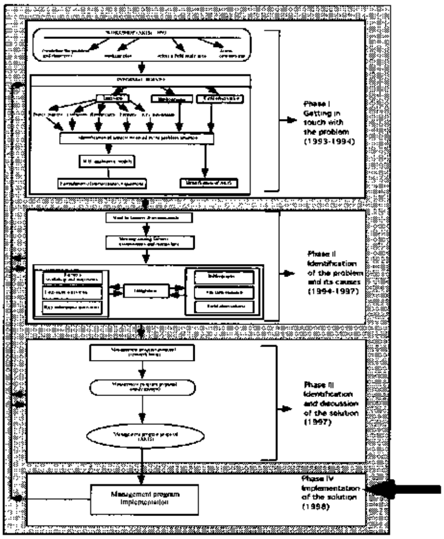
Actions of the management program	recommendations to farmers	suggestions to farmers	suggestions for research
➢ Actions to support removal of the cause of the Blackbird problem in rice			
✓ Reduction of losses during harvesting	X		
✓ Reduction of rice residues in waste heaps after pre-cleaning	X		
✓ Reduction of rice lost during transport to rice mills	X		
✓ Acceptance of hunting and trapping	X		
➢ Actions to reduce Blackbird damage during the rice sowing period			
✓ General recommendations			
• creating a good initial stand;	X		
• completely covering seeds after sowing;	X		
• increasing seed density while sowing;		X	X
• making seeds unattractive by natural repellants;			X
• application of seed coating;			X
• synchronizing sowing dates at various farms;	X		
• deep sowing; and			X
• increasing sowing density at 200 meters from the border of wood and swamps.		X	X
✓ Pre-germinated			
• do not sow pre-germinated seeds close to swamps and woods;	X		
• increasing sowing density within 200 meters from swamps and woods;		X	X
• do not remove all irrigation water after sowing and		X	X
✓ Broadcast sowing			
• covering seeds immediately after sowing and	X		
• Improving harrowing operation to make them more efficient in covering seeds after sowing.	X		
✓ No-tillage			
• improving soil compacting system to cover seeds completely	X		X
• increase mulshing in the no-tillage sowing system			X
➢ Actions to reduce damage from Blackbirds during the rice maturation period			
✓ Breeding rice varieties with some special characteristics (grain size, flag leaf, grain taste, grain roughness, grain palatability, greater resistance of natural degraining, better-husked grains, strong rice-stalks);			X
✓ No rice production within 200 m from woods and swamps;	X		
✓ First sowing should be done far from woods and swamps;		X	X
✓ Maintaining rice fields and its edges without weeds;	X		X
✓ Create "alternative" food source for Blackbirds;		X	X
✓ Drain rice fields as early as possible and			X
✓ Harvest rice as soon as moisture content in grain is appropriate.	X		

7. IMPLEMENTATION OF THE SOLUTION

7.1. Government and Blackbird

7.2. Dissemination of the management program

7.3. Evaluation of the program in the future



Salomon and Engel (1997) reported that the RAAKS procedure should end with the planning of how the recommendations of the management program be implemented in such a way that is acceptable to both farmer and other regional stakeholders. Once stakeholders became aware about the causes of the Blackbird problem they committed themselves to implementing the proposed recommendation. According to (Hamilton, 1995), stakeholders ready to adopt certain production systems for the benefit of both profitability and quality of life, need support from the Government. Legislation, rules or laws must sometimes be changed in order to support stakeholders' resolve to make production systems as sustainable as possible.

Since the beginning of the project, we encouraged Government to be involved with stakeholders' ideas for solving the Blackbird problem in an acceptable economical and environmental way. This chapter dwells on three issues. Firstly, questions related to the role of the Government before practical implementation of a Blackbird management program can commence are addressed. This is followed by a report on how the findings of the program were disseminated and implemented. Finally some suggestions are given concerning the evaluation of the Blackbird management program after implementation.

7.1. Government and the Blackbird

Our research project started with the identification of the real cause behind the Blackbird-problem. Sustainable (long-term) solutions used to be hampered by divergent ideas, definitions and interests within different groups ofstakeholders. Solving the problem was equal to managing "conflicting objectives and interests among farmers and environmentalists". However, environmentalists became most powerful after legislation for the protection of wild life in Rio Grande do Sul. Any kind of concerted actions for solving the Blackbird were useless. The workshop of 1993, organized on behalf of this study, brought among others, farmers, environmentalists and Government together for the first time. All participants recognized that everybody had a problem. The workshop of 1993 functioned according to the principles of "platform decision making" (Röling, 1994b). Indeed, the participants did make a decision. They agreed to accept that the Blackbird problem is very much related to human activities. If those activities could be changed, then it would be possible to solve the problem as well. It was decided by the participants to commence research into the possibilities for controlling population densities of Blackbirds in Rio Grande do Sul. The workshop, supported by the Government, first needed to prove that *Agelaius ruficapillus* is indeed a serious rice pest. Participants also accepted that any kind of Blackbird population control should respect governmental legislation concerning the protection of nature as well as general concern about quality of the environment.

Our project clearly showed that platform decision making (Röling, 1994b) is a good instrument for enabling stakeholders with conflicting interests concerning a certain development of their region, to reach consensus. We understood that the role of our research team was very important. We, as researchers, acted as facilitators, rather than 'experts' or extension people. Our knowledge was essential for raising the right questions at the right moment. We recognized the success of our role was due to careful preparations so that AKIS (The Agricultural Knowledge Information Systems) could be fully implemented. In fact, our work was nothing else than establishing the AKIS of Rio Grande do Sul more explicit.

All subsequent concerted actions concerning problem analysis and the resulting recommendations of the Blackbird control management plan have helped to clearly define the Blackbird problem. On the strength of the facts and figures published in this thesis farmers and research institutes formally requested IBAMA (Brazilian Institute for the Environment) to give permission for Blackbird control on the basis of the recommendations outlined in chapter 6. IBAMA stated that *A. ruficapillus* should be considered as a serious pest for rice farmers. The institute published its decision on May 26th, 1998. The decision also included important conditions relating to population control. Strict rules have been laid down concerning hunting or trapping of the bird, hunting periods, methods to be used, permissible areas and penalties where the conditions are not adhered to. The decision has been enforced one year and the effect of the Blackbird population control management will then be evaluated again by official research institutions. Based on this evaluation, the permission for Blackbird control can be re-validated or canceled.

7.2. Dissemination of the findings of the management program

Rio Grande do Sul is a large area. Our project area was only a part of it. The solutions that are proposed by our project team are therefore restricted to the support of stakeholders participating in our project region. Blackbirds are also a problem for many other parts of the State. Our solution might also be the solution for farmers elsewhere. Together with Kabourakis (1996), we considered dissemination of our management plan to all other parts of Rio Grande do Sul. The greater the acceptance, the easier it will be for local farmers to solve the problem.

According to Kabourakis (1996), we decided to identify all relevant farmer groups elsewhere in the State. We tried to create a network around them. This network was built on information streams among farmers. We identified such streams by identification of all their resources of agricultural knowledge (Salomon and Engel, 1997). We also identified the most important actors playing a role in trendsetting and decision-making (Röling and Engel, 1991).

Initially the management program was carried out in the coastal area between the Mirim Lagoon and the Atlantic Ocean (see Map 1). The management plan was not fully established, as hunting and trapping of Blackbirds was not accepted legally at that time. However, even without this legislation, important regional trendsetters were happy to accept most of the other recommendations from our team. Information, based on our AKIS analysis was supplied to agricultural companies, the big and influential farm named "4 Irmãos", Cooperative Extremo Sul and two CITE study groups in the Lagoon Mirim region.

Dissemination of information occurred naturally around the key organizations just mentioned. We observed that the management program became accepted in circles close to the key actors. The circles became wider and wider until most of the farmers had at least heard about if not already accepted the recommendations. Dissemination was completed in the Lagoon Mirim region by word of mouth. Additionally, nine meetings involving 720 farmers and extensionists took place between June and November 1997.

This process of dissemination was very effective and will no doubt be usefully applied to other areas of Rio Grande do Sul State. Further dissemination will be much easier now that under certain conditions, hunting and trapping of Blackbirds is permissible by the Government. However, considering the big number of stakeholders involved, a simple word to mouth dissemination may not be sufficient. A strong network of co-operating institutions and farmers is essential. Also, the Government must play an active role. Huge amounts of capital and human resources will be required to implement a large scale mobilization of related stakeholders so that they can benefit from a sustainable control of the Blackbird population.

IRGA (Rio Grande do Sul Rice Institute) is an extension organization in Rio Grande do Sul. IRGA is a well-respected and effective organization active in most regions of the State. It has decided to adopt the management program and is expected to organize meetings among farmers, research institutes and other relevant groups active in various regions. IRGA will create so called support groups with extensionists, key-farmers, agricultural companies, farmer cooperatives and private technical engineers as members. Such groups will be launched in five rice production districts in the State. Key-groups will maintain contact with our research group, in order to keep in touch with the original sources from which all recommendations within the management plan were built.

It is expected that support groups such as the one just mentioned, will make stakeholders aware about the cause of the Blackbird problem and consequently will help them implement the recommendations concerning reduction of damage by Blackbirds. Hunting and trapping methods according to IBAMA regulations will be part of future extension. As our research team could not participate in all of the five regions of the State, we produced relevant information materials[21,22]. These brochures serve as a reference for support groups and will help to inform farmers independently. In addition, our reports, summaries and recommendations have been distributed widely utilizing media such radio and newspapers as well increasing general public awareness. We wanted to show the public the extent to which farmers try to mange a problem in a way that demonstrates an environmental awareness and desire for nature conservation.

So far, there has been a very strong support for the management plan concerning Blackbird control. Only time will tell if this success is to continue.

---

[21] REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos*. Pelotas: EMBRAPA-CPACT. 63p. (Documentos; v.39)
Sponsorship: Banco do Brasil
Contents: A summary of papers presented during the M.B.R.M
Public orientation: extension service, researchers, and policy makers

[22] Silva, J. J. C. da, Cime, M. P., Franco, D. F. 1997. *Pássaro-Preto (Agelaius ruficapillus)* na cultura do arroz irrigado no Sul do Brasil. Pelotas: EMBRAPA-CPACT. 20 p. (Documentos; v. 38)
Sponsorship: Banco do Brasil
Contents: Information concern blackbird identification and bio-ecology, identification and quantification of damage caused by the blackbird, identification of the cause of the population increase of blackbirds, and blackbird management program.
Public orientation: rice farmers and extension service

7.3. Evaluation of the program in the future

Our approach appear to have be successful. Farmers have accepted recommendations. However, from a scientific point of view one might wonder about the results in the long term. Only hard facts will indicate if the management plan for control of Blackbird population has been effective. On the other hand, one can be reasonably sure about the success of the plan because farmers and other relevant stakeholders were directly involved in designing the present solution. The practical situation in this research indicated that farmers would never have accepted the recommendations if they did not trust them. We know farmers as acknowledged people with many experiences. Scientists sometimes consider them as empty buckets that they have to fill. Harrington et al. (1994) says that the general acceptance of promising recommendations always needs validation. Sooner or later, society or Government will raise questions such as " how do you know that progress had been made?" or "did you really see that sustainability has been obtained?"

We accept these questions as most relevant and have therefore desined some criteria that might help to evaluate the effectiveness of the management plan. Pretty (1994) states that such evaluations should be done in the light of criteria for sustainability. However, Pretty states that sustainability is not easy to define by experimental research. According to Posner and Gilbert, 1991 and Hiemstra et al., 1992 (both cited by Okali et al., 1994), it is necessary to monitor over a number of years and over large areas to evaluate some technologies. Stoyke and Waibel (1994) conclude that sustainable solutions do not exist in fact, because present generations can never say what the needs are of future generations.

We designed some indicators for the evaluation of the effectiveness of our management plan.

- ✓ *Monitoring population density of the Blackbird*
- ✓ *Monitoring the number of eggs laid by Blackbirds annually*
- ✓ *Annual calculation of rice losses during the winter period*
- ✓ *Observe the degree of damage caused by Blackbirds after sowing and during harvest*
- ✓ Determine the costs of Blackbird control
- ✓ *Observations by other stakeholders other than farmers alone*
- ✓ *Monitor the results from hunting and trapping*
- ✓ *Monitor diversity and abundance among bird species in irrigated rice regions*

Monitoring population density of the Blackbird

After implementation of our management plan, it is essential to monitor the population density of *A. ruficapillus*. It is suggested that five rice production regions are selected (Map 1). At each of these regions, population density will be determined according to the methodology described by Cirne et al. (1997b). According to Cirne, data has to be obtained through a transect method. Birds have to be counted up to 200 m from each side of the road. A direct count is used for situations where isolated birds or small flocks are found, while an estimation is used to count large groups.

Monitoring the number of eggs laid by Blackbirds annually

From our study, we learned that Blackbirds lay eggs from September (spring) to May (autumn) under natural conditions. This is not in line with what we learned from the literature available. Belton (1985) and Fallavena (1988) state that *A. ruficapillus* reproduce in February. Our study (Silva et al., 1997c) revealed a strong correlation between food supply during winter and the period of egg laying. Our recommendations will have been successful if the egg-laying period of the Blackbird returns to the natural period and if reduction of its population occurs. The time and intensity of egg laying activities on trees and swamps around rice crops needs to be observed. These environments can provide favorable conditions throughout the reproductive period. In addition, it is recommended that the reproductive activities along the irrigation channels where the invading plants predominate are also observed.

Annual calculation of rice losses during the winter period

Reduction of the Blackbird population should be followed by reduction of rice losses during harvest, pre-cleaning and transport to mills. The objective of this work is quantify losses of rice in order to verify work that deals with the blackbird diet and causes for the population increase of this bird. What follows is a suggestion on how to monitor the Blackbird feeding regime and the different sources of losses (rice residues in waste heaps after pre-cleaning; losses on roads during rice transportation and losses during rice harvest).

Identification of the Blackbird feeding regime. The aim of this work is to identify and quantify the main components of the feeding diet of *A. ruficapillus*. Captures of birds have to be made with the use of nets for later analysis in the laboratory of their stomach contents. The samples, with a maximum number of 20 individuals by sampling point, has to be done near the crops, in internal roads, near the houses and over rice cleaning residues during sowing, harvest and "no-crop" periods. The collected birds have to be kept frozen at -16°C for an indefinite period for later removal of the stomach contents. After removal, the material has to be put in labeled jars, with alcohol 70°, being immediately sent to the Seed Analysis Laboratory for identification of seeds.

Identification of seeds on rice residues in waste heaps after pre-cleaning. The objective of this work is to identify and quantify the seeds that are mixed with rice during harvest that serves as food for Blackbirds. For this purpose, harvested rice samples have to be collected at the harvest, directly from the trucks coming from the field and from waste heaps. The material collected has to be identified and immediately forwarded for identification in the seed laboratory.

Food available the Blackbird on roads during transportation of rice crop production. The rice that is lost by trucks on the roads during the transport of the crop, serves as food for blackbirds. The objective of this work is to quantify these losses. To obtain the data, plastic tarpaulins 25 m long and 4 m wide have to be spread along the roadsides, in a stretch where the asphalt is in good conditions. The grain that falls in the tarpaulin is collected and weighed in the laboratory.

Losses during harvest. The rice that is lost during harvesting serves as food for the Blackbird. The objective of this work is to quantify this loss. To obtain the data it is recommended that pre-harvesting losses, in front and behind the combine are evaluated (Alonço, 1997).

Observe the degree of damage caused by Blackbirds after sowing and during harvest

If our recommendations work, then the damage caused by the Blackbirds should decrease. Observations will be carried out during sowing and harvesting times, each year, in cages and paired unprotected sites. It will be done in different rice regions, all far away from swamps and woods.

Determine the costs of Blackbird control

Determination will be done on different rice regions based on information supplied by farmers [structured questionnaires]. Data from questionnaires will be presented and discussed in workshops with farmers and persons connected to rice production in Rio Grande do Sul.

Observations by stakeholders other than farmers alone

Goode and Hatt (1952, cited by Okali et al., 1994) state that field observations need validation. Reliability, relevance of data and data analysis are essential aspects of validation. Okali et al. (1994) says that farmers' own criteria for evaluation of techniques usually leads to discussions concerning how to interpret some of their observations. Drinkwater (1994) and Bentley (1994) accept that such differences are due to various cultural filters by which farmers and researchers are used to looking through. Röling (1994a) therefore advises that if we want to involve broader issues in our evaluation then, stakeholders other than individual farmers need to be involved. Therefore, non-structured interviews and discussions, individually or in small groups will be conducted. The objective of such interviews is to find out what the various stakeholders think and what observations they have concerning the blackbird-problem after implementation of the management program.

Monitor the results from hunting and trapping

Because quick returns to natural levels of Blackbird population densities are demanded, we recommended reducing population density by hunting and / or trapping. However, there is no certainty that this recommendation will produce the expected results. The reduction of the bird population will be determined by the rate and spread of bird-catching activities, as well by other actions within the management program. However, if the various rice regions adopt the management program differently, the degree of reduction in the Blackbird population can vary. For example, one can have the same reduction of population with a different adoption of hunting and trapping. Different situations can emerge from different combination of measures adopted by farmers. Under these this circumstances we hope to obtain sufficient data to analyze the success of the present recommendation. If the efficiency of the method to reduce bird population is demonstrated, IBAMA (Brazilian Institute for the Environment) will consider applying it to other similar situations in Brazil.

Monitor diversity and abundance among bird species in irrigated rice regions

There is a possibility that some farmer may want to use toxic baits [despite them being illegal] to control Blackbirds, which probably will kill no target species. As well, we expect that reduction in *A. ruficapillus* numbers may give room to other bird species. If the Blackbird has a big population, than they eat a certain amount of food [especially insects, which are one of their main source of protein]. If the insect population remains constant, than we may accept that food shortage occurs for others birds in the same region resulting in reduction of their populations. Therefore, we will monitor diversity and abundance among bird species in irrigated rice regions in order to verify these assumptions. Visits will be made to different rice regions of Rio Grande do Sul. Observations will covered the development stages of the rice between the vegetative stage and harvest. In addition, observation will be done on the rice stubble, during the period when there is no rice production. During each visit, field crops will be transected. Observations will be performed with the use of binoculars and a portable voice recorder. The number of individual of each species will be converted to a scale of relative abundance: rare (1 to 5 individuals), uncommon (6 to 20 individuals), common (21 to 100 individuals), frequent (101 to 1000 individuals) and abundant (over 1000 individuals). This study will help to identify possible reduction of avifauna in different regions. If it is demonstrated that such reduction is caused by the illegal use of toxic baits, than farmers can be prosecuted. If in addition, it can be proved that the Blackbird can affect other birds, then IBAMA can consider the Blackbird not just as a pest for rice production but as a problem for other bird species as well — reinforcing the necessity of population control.

8. THE STRENGHTS AND WEAKNESSES OF THE METHODOLOGIES BEHIND THE MANAGEMENT PLAN FOR CONTROLLING BLACKBIRD POPULATION DENSITIES

This study reflects our answer on questions about how to count, measure and weigh at higher levels of aggregation i.e. on the farms themselves rather than relying on experiments on conditioned fields or laboratories which produce hard data explaining relations between cause and effect. However, such results just refer to that particular experimental situation, not to the everyday reality of farmers in which many influences occur at one and the same time. Those results therefore are not very practical for farmers. They only have a meaning for scientists! In our study, the opposite holds true. We worked closely with farmers ideas, suggestions and experiences and integrated a number of designing methods described in literature. We integrated experimental knowledge with experiential ones. Our role as scientists changed from being a purely experimental researcher and problem solver to co-learning participants the with farmers themselves. Our results had meaning for the farmers and other regional stakeholders. However, can they be validated in a scientific way?

This chapter deals with the question. We made an inventory concerning all strong and weak aspects of our approach. Making it clear that we are aware of the scope of the methodologies behind our recommendations.

8.1. Strong aspects of the Blackbird project

Integration of actors' experience

- ✓ The Blackbird project was developed under socio-economic farm conditions. Researchers without farming experience gained valuable insight and appreciation for rice farmers, who have always had to cope with the constraints from producing in open, unpredictable field conditions. Moreover, through working together, farmers reached a better understanding concerning both researchers and environmentalists.
- ✓ The Blackbird project encouraged a multi-disciplinary approach. Special knowledge and skills were brought into the project. By becoming participants, these skills were applied to the problem situation and through participatory application, other participants acquired those skills. During the development of the research, all participants' knowledge was valued — this enhanced the participant's self esteem. Therefore, our understanding of a problem situation from multi-perspective point of view was improved and new ways of thinking about the problem situation emerged.
- ✓ The Blackbird problem situation varies in space and time. Our approach had to be interactive and flexible in order to accommodate this complexity. Therefore, positivistic and constructivistic approaches had to be combined during all phases of the research process. Consequently, we learned to spiral up and down, when

to view things to a smaller focus and when to view things in their entirety — depending on the kind of problem or situation we faced.

The design and implementation of the management program guarantees sustainable management for controlling Blackbird population densities

- ✓ Our management plan for controlling Blackbird population densities, avoids recommendations with obvious negative side effects. Our most important recommendations are cause-oriented (how to stop the abnormal outburst of population densities) rather than removing symptoms.

The management program proposal can be understood easily and is therefore acceptable to stakeholders and easy to extend

- ✓ The adoption of the Blackbird management program by farmers does not require economic investments. Most of the recommendations are towards a reorganization of the rice production system and include an economic return.
- ✓ By jointly investigating the problem situation, environmentalists and farmers are able to accept the results of the investigation and the management plan. Moreover, because they have trust in the plan [being an active participant themselves] they also help to spread it among their colleagues.
- ✓ During the field visits of Prof. Goewie to rice farmers in Southern Brazil, rice farmers used to reply to his challenging questions concerning the Blackbird problem, in terms of our recommendations. At that moment, it became clear that the farmers involved, had improved their understanding about the ecological dimensions of the Blackbird. However, what make us feel proud of our work was that those farmers began their answers with : "...our idea to address this problem is..." They clearly showed that the management plan had become theirs! They were also proud of it. There is no doubt that this feeling among farmers is an advantage that helps to spread the findings of a management program like the one presented in this thesis.

Intensive feedback

- ✓ Apart from recommendations, the Blackbird management program requested research institutions to investigate several questions related to the problem situation — questions that were identified during the research phase and during the MBRM (First Meeting on the Blackbird and its interaction with the Rice culture in the MERCOSUL countries). This intensive and positive feedback effect is a consequence of the participatory framework. By jointly investigating the problem situation, and by having their knowledge valued, participants' contribution was enhanced during all phases of the Blackbird research project.

Learning-in-process

- ✓ Our approach has the capacity to refine ideas on an on-going basis. It seeks improvements through an iterative process. Through a positive feedback, answers raise new questions and knowledge produces more knowledge. The approach utilises failure as a positive feature to be learned. Farmers and extensionists become active learners rather than passive receivers of information.
- ✓ According to Bawden (1991), learning should not be confused with teaching. A move from a teaching to a learning style has profound implications for agricultural institutions. The focus is less on what we learn and more on how we learn and with whom.

- ✓ According to Hamilton (1995), the generation and development of knowledge and information is not separated from the application of knowledge and information. Rather, the generation/development and the application of knowledge and information are intimately linked as part of the same process. This allows for rapid feedback from the application to the generation/development and in turn allows new directions from generation and development to be rapidly determined from the application, whether the application is judged to be successful or not.

8.2. Weak aspects of the Blackbird project

Large amounts of information are required to understand and implement the Blackbird management program

- ✓ Actions that will contribute to solving the Blackbird problem in a permanent way are causes- oriented (the abnormal increase of the blackbird population). As these actions are regionally focused, it is essential that most of the farmers fully adopt the management plan. Reluctant farmers might undermine expected results.
- ✓ A full acceptance of our management plan by all regional farmers is difficult to realise. Some farmers may prefer to wait until their neighbors have already started. They might think that efforts made by neighbors will be sufficient to control the problem, so they do not have to do anything. Such an attitude can not be predicted.
- ✓ To obtain as much as possible a full adoption of the management plan, farmers and those in extension services have to trust and fully understand the fundamental aspects of the program so that other will be encouraged to adopt its recommended practices.
- ✓ The Blackbird management proposal does not have a single solution. It is a sophisticated plan — more complex than conventional methods. Large amounts of information are required by farmers and extensionists to understand it. Farmers and extensionists have to increase their understanding of agroecological principles to process the information. It is clear that this constraint is the '*Achilles tendon*' of the Blackbird program.

Too many questions left unanswered

- ✓ The Blackbird project is a problem-oriented project based on a Systems perspective, focused on Sustainability and a Participatory action approach (SSP). This combination incited creativity amongst the participants. Creativity is a resource for farm bound innovation. A negative effect is that some questions remain unanswered, and will remain so for the immediate future. It might induce a deception among stakeholders not accustomed with participatory approaches. Deception in general, are disturbing factors in concerted regional actions. Therefore, in order to eliminate or reduce this potential negative effect, it is advisable to keep those actors constantly informed about the course, progress and performance of the research and management program with Blackbird.
- ✓ Our approach requires considerable amounts of data. In the case of Blackbird control, no such databases were available. Therefore, our study had to raise such data by itself and there were constraints here due to a shortage of money, expertise and time.
- ✓ One might wonder why a database concerning the Blackbird has never become part of institutional scientific agenda. The answer is surprising: research on those questions is not awarded, when such work becomes part of output

evaluation! In other words, a practical, problem oriented question gets lower prizing than theoretical questions.

It does not give quick outcomes

- ✓ The investigation of problems in complex agroecosystems is a time consuming task. Only by adequate definition, understanding of the problem situation and interacting with stakeholders, does it become possible to identify solutions. Hence, quick solutions are rarely possible in systems research.
- ✓ Agroecosystems respond slowly to management based on agroecological process (Kabourakis, 1996). I expect that after implementation of the Blackbird management program several cycles should run before obvious results appear. It might take more time if a substantial number of farmers do not adopt recommended actions.
- ✓ A slow response from the management plan might be considered as a failure of the recommendations. In order to avoid this interpretation of failure, farmers must be constantly well informed about the successful effects of actions, even if results are poor or not very obvious. Farmers like this kind of information, as they like to learn from colleagues.

8.3. Implications of the Blackbird project for farmers, organizations and their staff

- ✓ This study has unveiled positive and negative aspects of the management plan and of the approach. Those aspects have implications for farmers, researchers, sponsoring organizations and for the region as a whole. It is through open debate of these positive and negative aspects that one can improve ones' practice as a researcher.
- ✓ Increasingly, science is being faced with difficult complex situations. As the complexity of a problem situation increases the role of positivist science will have to change. A key to success will be the training of staff in the SSP approach. Constructivists must assist positivistic scientists to review their own paradigms. Individual actions will not meet the same needs as a multi-disciplinary team. Necessary skills [such as facilitation] will have to be developed by all team members.
- ✓ Openness to various types of local knowledge and participation in the design and implementation of research actions is essential.
- ✓ Farmers, our primary clients, will not dramatically change their role under a SSP approach. Farmers are for the most part curious. They have always been experimenters. However, they are used to doing their job, not explaining it. Therefore, through a SSP approach their capacity to experiment, learn and explain will be enhanced and empowered.
- ✓ Funding agencies should also change as a result of the increased adoption of a SSP approach. These agencies are facing an expanded demand from the clients to be allowed to participate.
- ✓ By involving farmers and extensionists on the [whole] research process, one might expect responsibility and ownership for decisions that must be made.

REFERENCES

ALONÇO, A. S. 1997. *Perdas na colheita mecânica de grãos*. Pelotas: EMBRAPA/CPACT. 27 p. (Documentos CPACT, v. 35)

ALTIERI, M. A. 1995. *Agroecology;* The science of sustainable agriculture. Westview Press, Boulder, USA. 443p.

ANDERSON, Molly D., LOCKERETZ, William. 1991. On-farm research techniques. In: REPORT ON A WORKSHOP, 1990, St. Paul, Minnesota. Medford: School of Nutrition Tufts University. 18p.

ANUÁRIO ESTATÍSTICO DO ARROZ-1988, 43, 1986/1987, Porto Alegre. Porto Alegre: IRGA. 36p.

AVERY, Michael. 1977. *Final project report on studies of bird damage to rice*. Bumbong, Lima: Rice Research Branch. p. 349 – 351 [01]

AVERY, Michael. 1980. Diet and breeding seasonality among a population of sharp-tailed munias, *Lonchura Striata*, in Malaysia. *The Auk*, 97: 160 – 166 [02]

AVERY, Michael. 1982. Nesting biology, seasonality, and mating system of malaysian fantail Warblers. *Condor*, 84: 106 – 109 [03]

AVERY, Michael. 1985. Annual molt pattern in a Malaysian population of fantail warblers (*Cisticola juncidis*). *The Condor,* 87: 346 – 349 [04]

AVERY, Michael. 1989. Experimental evaluation of partial repellent treatment for reducing bird damage to crops. *J. Appl. Ecol.*, 26: 433 – 439 [05]

AVERY, Micheal. 1994. Finding good food and avoiding bad food; does it help to associate with experienced flockmates? *Anim. Behav* , 48: 1371 – 1378 [06]

AVERY, Michael, NELMS, Curtis. 1990. Food avoidance by red-winged blackbirds conditioned with a pyraze odor. *The Auk,* 107: 544 – 549 [07]

AVERY, Michael, DECKER, David G. 1992. Repellency of cinnamic acid esters to captive red-winged blackbirds. *J. Wildl. Manage.*, 56(4): 800 – 805 [08]

AVERY, Michael, DECKER, David G, FISCHER, David L, STAFFORD, Tammy R. 1993. Responses of captive blackbirds to a new insecticidal seed treatment. *J. Wildl. Manage*, 579(3): 652 – 656 [09]

AVERY, Michael, DECKER, David G, FISCHER, David L. 1994. Cage and birds flight pen evaluation of avian repellency and hazard associated with imidacloprid-treated rice seed. *Crop Prot*, 13(7): 535 - 540 [10]

AVERY, Michael, DECKER, David G, HUMPHREY, John S, ARONOV, Evgeny, LINSCOMBE, Steven D, WAY, M. O. 1995. Methyl anthranilate as a rice seed treatment to deter birds. *J. Wildl. Manage*, 59(1): 50 – 56 [11]

AZAMBUJA, I.H.V., FAGUNDES, P.R.R., MAGALHÃES JR., A .M. de. 1996. Importância sócio econômica da lavoura de arroz irrigado. *In:* MAGALHÃES JR., A.M. de, FAGUNDES, P.R.R. *Agricultura real*; arroz irrigado. Pelotas: EMBRAPA-CPACT. p.7 - 8. (Documentos, 20)

BARKER, L. M., BEST, M., DOMJAN, M.(Eds.). 1977. Learning mechanisms if food selection. Waco, Texas, Baylor Univ. Press.

BASLER, V. G. 1993. Avaliação parcial de dispositivo colhedor de grãos, adaptados `as plataformas de colheitadeiras convencionais. *Lavoura Arrozeira*, Porto Alegre, 46(410): 6-7

BAWDEN, R. 1991. Systems thinking and practice in Agriculture. *Journal of Dairy Science*, 74: 2362-73

BEGHIN, I., CAP, M., DUJARDIN, B. 1988. Building a hypothetical causal model of a nutritional situation. *In: A Guide to nutricional assessment*. WHO. Annex.1, p. 39 - 48

BELTON, William. 1985. Birds of Rio Grande do Sul, Brazil. Part 2. Formicariidae through corvidae. *Bull. Am. Mus. Nat. Hist.*, New York, 180(1): 1 – 242 [12]

BENTLEY, Jeffrey, W. 1994. Simulating peasant farmer experiments in non-chemical pest control in Central America. *In*: *Beyond farmer first*; rural people's knowledge, agricultural research and extension practice. London: Intermediate Technology Publications. p. 147-150

BERTELS, A. 1979. Aves prejudiciais para agricultura no Rio Grande do Sul. *AGROS,* Pelotas, 14(1): 41 – 46 [13]

BESSER, Jerome F. 1973. Protecting seeded rice from blackbirds with methiocarb. *Int. Rice Comm. Newsletter*, Colorado, 22(3): 9 – 14 [14]

BESSER, Jerome F., GRAZIO, John W. de, GUARINO, Joseph. 1973. Decline of a blacbird population during seven years of baiting with a chemical frightening agent. In: BIRD CONTROL SEMINAR, 6 , Bowling Green, Ohio, 1973. *Reprints from Proceedings.* Bowling Green, Ohio: Bowling Green State University. p. 12 – 14 [15]

BEYER, W. Nelson, SPANN, James W., SILEO, Louis, FRANSON, Christian. 1988. Lead poisoning in six captive avian species. *Arch. Environ. Contam. Toxicol.*, 17: 121 – 130 [16]

BISHOP, Christine A., KOSTER, Margie, D., CHEK, Andrew A., HUSSELL, David J. T., JOCK, Ken. 1995. Chlorinated hydrocarbons and mercury in sediments, red-winged blackbirds (*Agelaius phoeniceus*) and tree swallows (*Tachyceneta bicolor*) from Wetlands in the Great Lakes-ST. Lawrence River Basin. *Environmental Toxicology and Chemistry*, 14(3): 491 – 501 [17]

BRAY, Olin E. 1973. Radiotelemetry for studying problem birds. In: BIRD CONTROL SEMINAR, 6, Bowling Green, Ohio, 1973. *Reprints from Proceedings.* Bowling Green, Ohio: Bowling Green State University. p. 198 – 200 [18]

BRUGGER, Kristin E., DOLBEER, Richard A. 1990. Geographic origin of red-winged blackbirds relative to rice culture in Southwestern and Southcentral Louisiana. *J. Field Ornithol.*, 61(1): 90 – 97 [19]

BRUGGER, Kristin E., LABISKY, Ronald F., DANEKE, Dennis E. 1992. Blackbird roost dynamics at millers lake, Louisiana; implications for damage control in rice. *J. Wildl. Manage.* 56(2): 393 – 398 [20]

BRUM, Argemiro J. 1995. *Desenvolvimento econômico brasileiro.* 15. ed. Ijuí: Vozes. 317p. (Série FIDENE)

BUCHER, E. H., BEDANO, P. E. 1976. *Bird damage problems in Argentina.* Domianki, Poland: Institute of Ecology. p.4 –16 [21]

CAMPBELL, Andrew. 1994. Community first - Landcare in Australia. *In*: *Beyond farmer first*; rural people's knowledge, agricultural research and extension practice. London: Intermediate Technology Publications. p. 252-258

CAPRA, Fritjof. 1982. *O ponto de mutação.* São Paulo: Cultrix. 447p.

CHAKRAVARTHY, K., GUBBAIAH. 1986. Pest contol and management; other pests. Bird damage to rice in Visveswaraiah Canal Tract (VCT). *Inter. Rice Res. Newsletter*, 11(2): 29 – 30 [22]

CHAMBERS, R. 1985. Shortcut methods in social information gathering for rural development projects. *In:* PROCEEDINGS OF THE 1985 INTERNATIONAL CONFERENCE ON RAPID RURAL APPRAISAL, Khon Kaen, Thailand. (Rural systems research and farming systems research projects).

CHAMBERS, R. 1992. *Methods for Analysis by Farmers*; The Professional Challenge. 12th Annual Farming Systems Symposium. Michigan: Michigan State University, Sept 13 -18, p. 420 - 434.

CHECKLAND, Peter. 1981. *Systems thinking, systems practice.* Chichester: John Wiley. 330p.

CIENTEC. 1998. Amônia na palha garante renda. *ZERO HORA*, Porto Alegre, RS

CIRNE, M. P., SILVA, J. J. C. da, BASTOS, M. C. 1997a. Aspectos bioecológicos do Garibaldi (*Agelaius ruficapillus*), e sua interação com a cultura do arroz irrigado. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos.* Pelotas: EMBRAPA- CPACT. 63p. (Documentos; v.39). p. 7-8

CIRNE, M. P., SILVA, J. J. C. da, FRANCO, D. F., VIEIRA, M. M., FREITAS, R. A. de. 1997b. Abundância populacional do pássaro-preto (*Agelaius ruficapillus*) em Rio Grande, RS, 1994-97. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos.* Pelotas: EMBRAPA- CPACT. 63p. (Documentos; v.39). p. 36-38

CLIMANÁLISE. 1986. Boletim de Monitoramento e análise climática. *Aspectos da climatologia dinâmica no Brasil.* Cachoeira Paulista, SP: INPE/CPTEC. 124p. (Número especial)

COMMITTEE ON THE ROLE OF ALTERNATIVE FARMING METHODS IN MODERN PRODUCTION AGRICULTURE. 1989. *Alternative agriculture.* Washington: National Academy Press. 448p.

CONWAY, G. R. 1985. Agricultural ecology and farmind systems research. *In:* REMENYI, J. V. (ed). *Agricultural Systems Research For Developing Countries.* ACIAR Proceedings. Australian: Australian Centre For International Agricultural Research. n. 11, p. 43 - 59

CONWAY, G. R., McCRAKEN, J. A., PRETTY, J. N. 1987. *An introduction to agroecosystem analysis.* London: International Institute for Environment and development. p. 1 – 29

CORREA, N., CAICEDO, L., FEDDES, A., LOUZADA, S., BELTRAME, S. 1997. Consumo de água na irrigação do arroz por inundação. *Lavoura Arrozeira*, Porto Alegre, 50(432): 3 – 8

COSTA, Juana I. Pergolani de. 1950. *El pajaro denominado "Varillero" o "Congo" Agelaius ruficapillus ruficapillus Vieillot como plaga de los arrozales en Santa Fé.* Buenos Aires: Minister'o de Agricultura Y Ganadeira. 14p. (Serie B; v. 16) [23]

CRASE, Frederick T, HAVEN, Richard W. de. 1977. Food of nestling tricolored blackbirds. *Condor,* 79(2): 265 – 269 [24]

CRASE, Frederick T., HAVEN, Richard W. de. 1978. Food selection by five sympatric California blackbird species. *Calif. Fish and Game,* 64(4): 255 – 267 [25]

CUNHA, Gilberto. 1997. Agricultura sustentável; o que é isso? *Jornal do SEPA,* abr. 1997

CUNHA, Noel Gomes da, SILVEIRA, Ruy José da Costa, SEVERO, Carlos Roberto. 1996. *Estudo dos solos do Município de Rio Grande.* Pelotas: UFPEL; EMBRAPA/CPACT. 82p. (Documentos CPACT; v.16)

CUSTER, Thomas W., HILL, Elwood F., OHLENDORF, Harry M. 1985. Effects on wildlife of ethyl and methyl parathion applied to California rice fields. *Calif. Fish and Game,* 71(4): 220 – 224 [26]

DANEKE, Dennis, DECKER, David G. 1988. Prolonged seed handling time deters red-winged blackbirds feeding on rice seed. In: VERTEBRATE PEST CONFERENCE, 13, California, 1988. *Proceedings.* California: University of California. p. 287 – 292 [27]

DECKER, David G, AVERY, Michael L, WAY, M. O. 1990. *Reducing blackbird damage to newly planted rice with a nontoxic clay-based seed coating.* California: University of California. p. 327 – 330 [28]

DIAS, R. A., CIRNE, M. P., SILVA, J. J. C. da. 1997. A Relação entre a avifauna e a lavoura de arroz irrigado no sul do Rio Grande do Sul: uma análise prévia. 1997. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos.* Pelotas: EMBRAPA-CPACT. 63p. (Documentos; v.39). p. 14

DRINKWATER, Michael. 1994. Developing interaction and understanding: RRA and farmers research groups in Zambia. *In: Beyond farmer first*; rural people's knowledge, agricultural research and extension practice. London: Intermediate Technology Publications. p. 133-139

EMBRAPA-CPACT. 1993. *Plano Diretor do Centro de Pesquisa Agropecuária de Clima Temperado.* Pelotas, RS. 41p.

ENGEL, P.G.H., 1997. The social organization of innovation; *A focus on stakeholder interaction.* In: Engel, P. G. H., SALOMON, M.L. (eds). *Facilitating innovation for development*; A RAAKS resource box. *Amsterdan*: KIT/CTA/STOAS

ENGEL, P.G.H., SALOMON, M.L., FERNANDEZ, M.E., DIECKMANN, N. 1995. RAAKS; a *participatory methodology for improving innovative performance in agriculture;* version 5.2. wageningen: AUW/CTA/IAC/IARED. 135p.

FALLAVENA, Maria Alice Bello. 1988. Alguns dados sobre a reproducão do Garibaldi, *Agelaius r. ruficapillus* (Icteridae, Aves) em lavoura de arroz no Rio Grande do Sul. *R. Bras. Zool.*, São Paulo, 4(4): 307 – 317 [29]

FARRINGTON, John. 1988. Farmer participatory research. *Experimental Agriculture*, 24: 269 - 279

FARRINGTON, John, MARTIN, Adrienne. 1988. *Farmer participation in agricultural research*; a review of concepts and practices. London: Overseas Development Institute. 79p. (Occasional Paper, 9)

FEARROZ. 1995. *Relatório 1995.* Porto Alegre: Agriplan / Planejamento Agropecuário. 8p.

FLICKINGER, E.L., KING, Kirke A., STOUT, William F., MOHN, Milton M. 1980. Wildlife hazards from furadan 3G applications to rice in Texas. *J. Wildl. Manage,* 44(1): 190 – 197 [30]

FLICKINGER, E.L., MITCHELL, Christine A., WHITE, Donald H., KOLBE, Elizabeth J. 1986. Bird poisoning from misuse of the carbamate furadan in a Texas rice field. *Wildl. Soc. Bull.*, 14(1): 59 – 62 [31]

FLICKINGER, Edward L., WHITE, Donald H., MITCHELL, Christine A., LAMONT, Thair G. 1984. Monocrotophos and dicrotophos residues in birds as a result of misuse of organophosphates in Matagorda County, Texas. *J. Assoc. Off. Anal. Chem.*, 67(4): 827 – 828 [32]

FLORES, E.; NASSIF, C. F. 1993. Arroz nos Estados Unidos. *Lavoura arrozeira*, 46(409): 33-40

FONTANA, A., FREY, J. H. 1994. Interviewing: the art of science. In: DENZIN, Norman, LINCOLN, Yvonna. (ed.). 1994. *Handbook of qualitative research.* London: SAGE Publications. p. 361-376

FRANCO, D. F., CIRNE, M. P, SILVA, J. J. C, ASMUS, M. L., MACEDO, V. L. C, NACHTIGAL, E. C. 1997. Identificação do regime alimentar de *Agelaius ruficapillus* (EMBERIZIDAE – AVES) na planície costeira da lagoa Mirim, RS, Brasil, 1994-96. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos.* Pelotas: EMBRAPA- CPACT. 63p. (Documentos; v.39). p. 16-17

FRANCO, D. F., ELIAS, M. C., ROMBALDI, C. V., SILVA, J. A., DIAS, A. R. G. 1996. Colheita, pós-colheita e industrialização. *In:* MAGALHÃES JR., A.M. de, FAGUNDES, P.R.R. *Agricultura real*; arroz irrigado. Pelotas: EMBRAPA-CPACT. p.66-73. (Documentos, 20)

FRANK, F. R., SCHAFER JR., E. W., GAURINO, J. L. 1970. Laboratory and field studies with an avian repellent for sprouting seeds. *In:* BIRD CONTROL SEMINAR, 5, Bowling Green, Ohio, 1970. *Reprints from Proceedings.* Bowling Green, Ohio: Bowling Green State University, 1970. p.86 – 89 [33]

FRAQUELLI, Jane Aita. 1993. A lavoura capitalista do arroz e a crise de 1926; a ação do Estado e a criação do Sindicato Arrozeiro. In: DACANAL, José Hildebrando, SERGIUS, Gonzaga (org.). *RS economia & pol'tica.* Porto Alegre: Mercado Aberto. p. 329 - 357

FUKOSHIMA, M. T. 1997. Danos provocados pelo Chupim, *Molothrus bonariensis* (Gemel) em função da arquitetura da folha bandeira do arroz irrigado. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos.* Pelotas: EMBRAPA-CPACT. 63p. (Documentos; v.39). p. 49-50

FUSSELL, W. 1995. Treating the cause, not the symptoms. *ILEIA Newsletter*, 11(3): 30 - 31.

GALLI, J., TERRES, A. L., GASTAL, F. L. C. 1985. Origem, histórico e caracterização da planta de arroz. *In*: EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Fundamentos para a cultura do arroz irrigado. Campinas: Fundação Cargill. p. 1 – 14

GASPAROTTO, E. 1997. A eleição traçará o rumo da agricultura. *Zero Hora*, Porto Alegre, RS

GAVIN, Thomas A., HOWARD, Ronald A., MAY, Bernie. 1991. Allozyme variation among breeding populations of red-winged blackbirds; the California conundrum. *The Auk,* 108(3): 602 - 611 [34]

GENTIL, L. V. 1985. Redução das perdas de grãos na colheita. *Raízes*, São Paulo, 10 (105): 9-12.

GILL, Elaine L., SERRA, Maria B., CANAVELLIS, Sonia B., FEARET, Chris J., ZACCAGNINI, Maria E., NADIAN, Allan K., HEFFERNAN, Marie L., WATKINS, Richard W. 1994. Cinnamamide prevents captive Chestnut-capped blackbirds (*Agelaius ruficapillus)* from eating rice. *Int. J. Pest Manage,* 40(2): 195 - 198 [35]

GOEWIE, E. A. 1999. *Agronomic designing*: hard and soft aspects addressed in agroecosystem development. In press.

GOEWIE, E. A. 1993. Ecologische landbouw: een duurzamm perspecief? Intreerede. Landbouwuniversiteit Wageningen. The Netherlands.

GOMES, A. da S. 1997. Coord. Viabilização e difusão do sistema de plantio direto no planalto sul riograndense e na planice costeira do RS. *Relatório Técnico de 1994 a 1997* Pelotas: EMBRAPA-CPACT. p. 42 (Documentos, 29).

GOMES, A. da S., PETRINI, J. A. 1996. Manejo de água em arroz irrigado. *In:* MAGALHÃES JR, A.M. de, FAGUNDES, P.R.R. *Agricultura real*; arroz irrigado. Pelotas: EMBRAPA-CPACT. p.44 - 53 (Documentos, 20)

GOMES, A. da S., PETRINI, J. A., PARFITT, J. M. B., VERNETTI Jr, F. de J. 1996. Manejo de solos de arroz irrigado. *In:* MAGALHÃES JR, A.M. de, FAGUNDES, P.R.R. *Agricultura real*; arroz irrigado. Pelotas: EMBRAPA-CPACT. p.19 - 26 (Documentos, 20)

GONZALEZ, A. B., MADAIL, J. C., SILVA, J. J. C., BE, N. V., MWAMBAZI, T., PAGHUBASAN, V., BOEF, W. de. 1995. FAMILY FARMS UNDER THREAT: The sustainability of peach production systems in South Brazil. Wageningen: International Centre for development-oriented Research in Agriculture (ICRA Working Document Serie No. 42)

GORENZEL, W. Paul, MARCUM, Daniel B., SALMON, Terrel P. 1986. Application of a benefit-cost model to blackbird damage control in wild rice. *In:* VERTEBRATE PEST CONFERENCE, 20, California, 1986. *Proceedings*. California: University of California. p. 269 – 274 [36]

GRAZIO, John W. de. 1968. New materials for bird control. *In:* BIRD CONTROL SEMINAR, 4, Bowling Green, Ohio, 1968. *Proceedings*. Bowling Green, Ohio: Broling Green State Univesity. p.165 – 166 [37]

GRAZIO, John W. de, BESSER, Jerome F. 1970. Bird damage problems in Latin America. *In:* VERTEBRATE PEST CONFERENCE, 4, West Sacramento, California, 1970. Re*printed from Proceedings*. p. 162 – 167 [38]

GRAZIO, John W. de, BESSER, Jerome F. 1975. Field investigations of monk parakeet damage to sunflowers and corn in Uruguay. *Trip Report.* [39]

GREEN JR., Victor E. 1973. Birds injurious to the world rice crop; species, damage and control. Part 2, Western hemisphere. *Riso*, Milan, 22(1): 59 – 68 [40]

GUARINO, Joseph L., SCHAFER JR., Edward W. 1973. A program for developing male chemosterilants for red-winged blackbirds. *In:* BIRD CONTROL SEMINAR, 6, Bowling Green, Ohio, *Reprints from Proceedings.* Bowling Green, Ohio: Bowling Green State University. 200 – 205 [41]

GUILFORD, T., NICOL, C., ROTHSCHILD, M., MOORE, B. P. 1987. The biological roles of pyrazines: evidence for a warning odour function. *Biol. J. Linn. Soc.*, 31: 113-128.

GUIMARÃES, H.M.A., MACHADO, J.R., MONTEIRO, F.J.F. 1997. Influência do ponto de colheita no centro branco de arroz (*Oriza sativa* L.) irrigado em diferentes épocas de semeadura. *In:* REUNIÃO DA CULTURA DO ARROZ IRRIGADO, 22, 1997, Balneário Camboriú, SC. Itajaí: EPAGRI, 1977. p. 506-507

GUIVANT, Julia S. 1994. Encontros e desencontros da sociologia rural com a sustentabilidade agrícola. *BIB*, Rio de Janeiro, 38: 51 - 78.

HAAG Kin H., JOYCE Joseph C., HETRICK Willie M., JORDAN Jacqueline C. 1987. Predation on waterhyacinth weevils and other aquatic insects by three Wetland birds in Florida. *Florida Entomologist*, 70(4): 457 – 471 [42]

HAMILTON, N. A. (Gus). 1995. *Learning to learn with farmers;* a case study of an adult learning extension project conducted in Queensland, Australia 1990-1995. Wageningen: Universiteit. 196p.

HARRINGTON, L., JONES, P., Winograd, M. 1994. *Operationalizing the notion of sustainability*; a total productivity approach. Paper presented at the 6th International Meeting of RIMISP, Campinas, Brazil. p. 2 - 23

HARRINGTON, L. W., READ, M. D., GARRITY, D. P., WOOLLEY, J., TRIPP, R. 1989. Approaches to on-farm client oriented research; similarities, differences and future directions. *In:* SUKMANA, S., AMIR, P. MULYADI, D. M. *Developments in procedured for farming systems research*. Indonesia: Agency for agricultural Research and Development.

HART, R. D. 1981. An ecological systems conceptual framework for agricultural research and development. *In*: SHANER, W. W., PHILIPP, P. F., SCHMEHL, W. R. *Readings in farming systems research and development*. Colorado: Consortium for International Development. p. 50 -65

HAVEN, Richard W. de. 1971. Blackbirds and the California rice crop. *The Rice J.*, 74(8): 1 – 4 [43]

HAVEN, Richard W. de., GUARINO, Joseph L., CRASE, Frederick T., SHAFER, Edward W. Jr. 1971. Methiocarb for repelling blackbirds from ripening rice. *Int. Rice Comm. Newsletter*, 20(4): 25 - 30 [44]

HAYES, Jack P., CASLICK, James W. 1984. Nutrient deposition in cattail stands by communally roosting blackbirds and starlings. *The American Midland Naturalist,* 112(2): 320 – 331 [45]

HELTON, Tena. 1995. Protect your fields by control of blackbirds. *Rice J.*, 15: 20 - 22 [46]

HOLLER, Nicholas R., NAQUIN, Howard P., LEFEBVRE, Paul W., OTIS, David, L., CUNNINGHAM, Donald J. 1982. Mesurol for protecting sprouting rice from blackbird damage in Louisiana. *Wildl. Soc. Bull.*, 10(2): 165 - 170 [47]

HRUSKA, Allan Jr. 1990. Government Pesticide Policy in Nicaragua 1985-1989. *Global Pesticide Monitor* 1(2): 3-5.

IBGE. 1986. *Levantamento de recursos naturais;* folha SH.22 Porto Alegre e parte das folhas SH.21 Uruguaiana e SI.22 Lagoa Mirim. Rio de Janeiro: IBGE. v.33

INFELD, José Alceu. 1988. Influência da temperatura e da radiação solar no arroz. *In:* CURSO DE ATUALIZAÇÃO DA CULTURA DE ARROZ IRRIGADO, 1, Bagé. Bagé: Faculdade de Agronomia; FAT-FUNBA.

INFELD, J. A., MAGALHÃES JR., A. M. de., PETRINI, J. A., FAGUNDES, P.R.R. 1996. Espaçamento e densidade de semadura. *In:* MAGALHÃES JR., A.M. de, FAGUNDES, P.R.R. *Agricultura real*; arroz irrigado. Pelotas: EMBRAPA-CPACT. p.37 - 38. (Documentos, 20)

IRGA. 1980. *O arroz no Rio Grande do Sul.* Porto Alegre, RS. 26 p.

IRGA / NATE. 1993. *Previsão de área a ser plantada;* arroz irrigado safra 1993/94. Porto Alegre, RS.

IRGA / NATE. 1997. *Previsão de área a ser plantada;* arroz irrigado safra 1997/98. Porto Alegre, RS.

ITEPA. 1996. *Banco de dados da zona sul-RS/ITEPA.* Pelotas: EDUCAT. 175p. (Boletim Informativo, 7)

ITEPA. 1997. *Banco de dados da zona sul-RS/ITEPA.* Pelotas: EDUCAT. 200p. (Boletim Informativo, 8)

JAMES, Frances C. 1991. Complementary descriptive and experimental studies of climal variation in birds. *Amer. Zool.*, 31: 694 – 706 [48]

JOHNSON, David W., JOHNSON, Frank P. 1994. *Joining together*; group theory and group skills. ed. Boston: Allyn and Bacon. 609p.

JONES, J. P.; WARD, P. 1976. The level of reserve protein as the proximate factor controlling the timing of breeding and clutch size in the red-billed quelea, *Quelea quelea, Ibis* 118: 547-574

KABOURAKIS, Emmanouil. 1996. *Prototyping and dissemination of ecological olive production systems*; A methodology for designing and a first step towards validation and dissemination of prototype ecological olive production systems (EOPS) in Crete. Wageningen: Universiteit. 121p.

KEMPF, D. et al. 1997. Avaliação de genótipos introduzidos no Rio Grande do Sul, safras 1995/96 e 1996/97. *In:* REUNIÃO DA CULTURA DO ARROZ IRRIGADO, 22, 1997, Balneário Camboriú, SC. Itajaí: EPAGRI, 1977. p. 49-51

LIGHTFOOT, C. and R. Barker 1988. On-farm trials: a survey of methods. *Agricultural Administration and Extension,* 30: 15-23.

LINSCOMBE, S. D., WILSON, E. A., HARPER, G. A. 1990. *Bird management in rice: blackbird preference for two rice varieties.* [s.n.] . p. 180 – 181 [49]

LINZ, George M., LAURA, A. Mendonza, BERGMAN, David L., BLEIER, Willeam J. 1995. Preferences of three blackbird species for sunflower meats, cracked corn and brown rice. *Crop Prot.,* 14(5): 375 – 378 [50]

LITTLE, F., GEER, J. van. 1994. *Identifying Problems. In*: *GOAL-ORIENTED* project planning. p. 5 - 10

LOPES, João Simões. 1914. *Cultura do arroz*; palestras agrícolas. Pelotas, RS. 114p.

MARCUM, Daniel B., GORENZEL, W. Paul. 1994. Grower practices for blackbird control in wild rice in California. *In*: VERTEBRATE PEST CONFERENCE, 16, California, 1994. *Proceedings.* California: University of California. p. 243 – 249 [51]

MEANLEY, Brooke. 1971. *Blackbirds and the Southern rice crop.* Washington: Fish and Wildlife Service. 64p. [52]

MERRILL-SANDS, D., BIGGS, S. D., BINGEN, R. J., EWELL, P. T., McALLISTER, J.L., POATS, S.V. 1991. Integrating on-farm research into national agricultural research systems: lessons for research policy, organization and management. *In*: TRIPP, R. (ed.) *Planned change in farming systems.* Chichester, UK: John Wiley and Sons Ltd. p. 287-316

METTRICK, Hal. 1993. A farming systems approach. *In: DEVELOPMENT oriented research in agriculture*; an ICRA Textbook. Wageninger: ICRA.287 p.

MORSE, M. J. 1994. Designing Funded Qualitative Research. In: DENZIN, Norman, LINCOLN, Yvonna. (ed.). 1994. *Handbook of qualitative research.* London: SAGE Publications. p. 220-235

MOTT, Donald F., CUMMINGS, John L., NAQUIN, Howard P. 1982. Inefficacy of avritol FC-corn CHOPS-99 for preventing blackbird damage to sprouting rice. *Prot. Ecol.*, 4: 387 - 392 [53]
MOULTON, Daniel W. 1979. Evaluation of methiocarb for repelling blackbirds from cultivated wild rice. *J. Wild. Manage.*, 43(3): 747 – 751 [54]
NAQUIN, H. P., LeBOEUF, E. A. 1979. Repellency of potential avicides to depredating blackbird populations in ripening rice fields. *Annual Prog. Rep.*, Louisiana, 71: 242 - 245 [55]
NAQUIN, H. P., MOTT, D. F., CUMMINGS, J. L., LeBOEUF, E. A. 1979. Effectiveness and safety of avitrol FC-CORN CHOPS-99 for protecting sprouting rice from blackbird damage. *Annual Prog. Rep.*, Louisiana, 71 : 231 – 236 [56]
NOÉ PINO, Cézar Augusto. 1989. *Manual de uso ambiental de Plaguicidas.* Banco Centroamericano de integración Económica, Tegucigalpa.
ODUM, E. P. 1984. Properties of Agroecosystems. In Agricultural Ecosystem, Lowrance, R.; Stinner, B. R. & House, G. J. (eds). Jonh Willey e Sons. New York.
OKALI, Christine, SUMBERG, James, FARRINGTON, John. 1994. *FARMER participatory research*: rhetoric and reality. Southampton: Intermediate Technology Publications. 159p.
OSHEIM, D. L., ROSS, P. F., KECK, L. D., TIPTON, B. L. Carbofuran toxicosis in cattle; case history and analytical method. *Vet. Hum. Toxicol.*, 27(5): 386 – 387 [57]
PLOEG, J. D. van der. 1994. Styles of farming: an introductory note on concepts and methodology. In: J. D. van der Ploeg. A. Long (eds) (1994), Born from within; practice and perspectives of endogenous rural development. Van Gorcum, Assen.
PORTO, R. O. 1996. Agricultura e desenvolvimento. *Lavoura Arrozeira*, Porto Alegre, 49(429): 19-22
PÖYSÄ, H. 1992. Group foraging in patchy environments: the importance of coarse-level local enhancement. *Ornis Scand.*, 23: 159-166
PRETTY, J. 1994. *Alternative systems of inquiry for sustainable agriculture.* Paper prepared for the 13th ICRA Course, ICRA, Wageningen.
QUADRO, P. 1995. Ocupacão do extremo sul brasileiro. *In:* PIRAGINE, M.L.R. *Rio Grande portuguesa com certeza.* Rio Grande, RS. p.26 - 38
RAMBO, P. Balbuíno. 1994. *A Fisionomia do Rio Grande do Sul*. 3. ed. São Leopoldo: UNISINUS. 473p.
REIS, A. V., MACHADO, A., ALONÇO, A., TOESCHER, C., TILLMANN, C., MACHADO, R. 1996. Alterações na distribuição e volume de palha na colheita do arroz irrigado com plataforma recolhedora. In: WORKSHOP SOBRE MECANIZAÇÃO AGRÍCOLA NA REGIÃO DE CLIMA TEMPERADO, 2, 1996, Pelotas. Desafios da mecanização agrícola frente a consolidação do MERCOSUL. *Anais.* Pelotas : UFPEL / EMBRAPA/ UFSM. p. 111 - 114
RETI, J. 1995. Colheita e pós-colheita; pesquisa da EMBRAPA procuram diminuir desperdícios. **Folha da EMBRAPA**, Brasília, mar./abr., ano 4, n. 18, p.6-7
REUNIÃO DA CULTURA DO ARROZ IRRIGADO, 21, 1995, Porto Alegre. *Arroz irrigado*; recomendações técnicas da pesquisa para o sul do Brasil. Porto Alegre: IRGA, 1996.
REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos.* Pelotas: EMBRAPA-CPACT. 63p. (Documentos; v.39)
RIBEIRO, Darcy. 1996. *O povo brasileiro*; a formacão e o sentido do Brasil. São Paulo: Companhia das Letras. 476p.
RICHMOND, Barry, PETERSON, Steve, and VESCUSO, Peter. 1987. An Academic Users's Guide to *Stella*. Lyme, New Hampsire. 392p.
RODALE, J. I. 1946. *Abonos aorgánicos*; el cultivo de huertas y jardines com compuestos organicos. Buenos Aires: Tres Emes. 278p.
RODRÍGUEZ, Ethel. 1994. Manejo de aves plaga en cultivo de arroz. *In:* INIA. *Arroz*; resultados experimentales 1993-94. Montevideo: Programa Nacional do Arroz. v.2 (Serie Actividades de Difusóon, 25) [58]
RODRÍGUEZ, Ethel, LÓPEZ, Pablo, CAMACHO, Angeles, ARBALLO, Eduardo. 1995. Manejo de aves plaga en cultivo de arroz; informes de advances. In: INIA. *Arroz;* resultados experimentales 1994-95. Montevideo: Programa Nacional do Arroz. p. 1 - 4 (Serie Actividades de Difusión, 62) [59]

RODRÍGUEZ, Ethel, LÓPEZ, Pablo, CAMACHO, Angeles, ARBALLO, Eduardo, CHEBATAROFF, Nicolás. 1996. Manejo de aves plaga; informes de advances. In: INIA. *Arroz;* resultados experimentales 1995-96. Montevideo: Programa Nacional do Arroz . p. 1 - 6 (Serie Actividades de Difusión, 103)

RÖLING, N. G. 1990. The Agricultural research-technology transfer interface; a Knowledge systems perspective. *In:* KAIMOWITZ (ed.). *Making the link;* Agricultural research and technology tranfer in developing countries. Colorado: ISNAR, Westview Press. p. 1 - 35.

RÖLING, N. G. (1994a). Facilitating sustainable agriculture: turning policy models upside down. *In*: *Beyond farmer first*; rural people's knowledge, agricultural research and extension practice. London: Intermediate Technology Publications. p. 245-247

RÖLING, N. G. (1994b). Platforms for decision making about eco-systems. In: T*he future of the land.* ed. L. Fresco, L. Chichester: John Wiley.

RÖLING, N. G., ENGEL, P. G. H. 1991. The development of concept of agricultural knowledge information systems (AKIS); implications for extension. *In*: RIVERA, W. M., GUSTAFSON, D. J. (eds). *Agricultural extension*; worldwide institutional evoluation and forces for change. Amsterdam: Elsevier . p. 125 – 137

RUCATTI, Evely, KAYSER, Victor Hugo. 1996. Custo de produção da lavoura de arroz irrigado do Rio Grande do Sul. *Lavoura Arrozeira*, 49(425): 25 – 29

RUCATTI, Evely, KAYSER, Victor Hugo. 1997. Origem e destino das importações de arroz no Rio Grande do Sul. *Lavoura Arrozeira*, 50(430): 36 – 39

RUEDEL, José. 1995. Plantio Direto na Região de Cruz Alta. Convênio FUNDACEP/BASF. FUNDACEP. FECOTRIGO, Cruz Alta, RS.

RUTGER, Robyn J. 1990. Control of blackbirds; challenge for growers. *Rice J.* p. 6 - 9 [60]

SAINT-HILAIRE, Auguste de. 1987. *Viagem ao Rio Grande doSul.* PortoAlegre: Martins Livreiro. 496p.

SALOMON, M.L., ENGEL, P.G.H., 1997. Networking for innovation; *A participatory actor-oriented methodology. In*: Engel, P. G. H., SALOMON, M.L. (eds). *Facilitating innovation for development*; A RAAKS resource box. *Amsterdan*: KIT/CTA/STOAS

SANINT, L.R. 1997. Evolucion tecnológica, perspectivas futuras y situacion mundial del arroz. *In*: REUNIÃO DA CULTURA DO ARROZ IRRIGADO, 22, 1997, Balneário Camboriú, SC. *Palestras* . Itajaí: EPAGRI, 1997. p. 7 - 30

SCHAFER, Edward W., BRUNTON, Ronald B. 1971. Chemicals as bird repellents; two promising agents. J. Wildl. Manage., 35(3): 569 – 573 [61]

SCHIOCCHET, M. A., MACHADO, J.R. 1997. Efeito da parboilização de arroz nas características culinárias. *In:* REUNIÃO DA CULTURA DO ARROZ IRRIGADO, 22, 1997, Balneário Camboriú, SC. Itajaí: EPAGRI, 1977. p. 501-502

SCHUBERT, B., BACKHAUS, C., HUMANN, J., KLEIPASS, L., MICHEL, K., SEYFFERTH, A., WINDISCH, P., ZOUMER, K. 1991. A logical framework for planning agricultural research programs. Manila, Philippines: IRRI. p. 1- 21

SCOTT, D. A., CARBONELL, M. 1986. *Inventário de humedales de la region Neotropical.* Cambridge: IWRB, Slimbridge y UICN.

SHIELDS D. 1993. What is the logical framework? A step-by-step user's guide. *The Rural Extension Bulletin,* 1: 15 - 20

SILVA, Flavio, CAYE, Carmen E. 1992. *Lista de aves*; Rio Grande do Sul. Porto Alegre: Pontificia Universidade Católica do Rio Grande do Sul. 28p. (Divulgações do Museu de Ciências da PUCRS) [62]

SILVA, J. J. C. da, ASMUS, M. L., BONILHA, E., CIRNE, M., FRANCO, D., BORGES, R. 1997 (a). Modelagem ecológica do pássaro-preto (*Agelaius ruficapillus*) em áreas de produção de arroz irrigado no Rio Grande do Sul, Brasil. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos.* Pelotas: EMBRAPA- CPACT. 63p. (Documentos; v.39). p. 54-58

SILVA, J. J. C. da, CIRNE, M., FRANCO, D. 1997 (b). *Pássaro-Preto (Agelaius ruficapillus);* na cultura do arroz irrigado no Sul do Brasil. Pelotas: EMBRAPA. (Documentos; v. 38)

SILVA, J. J. C. da, CIRNE, M., FRANCO, D., ASMUS, M. L., ECHEVERRIA, A., DIAS, A. 1997 (c). Identificação das causas do aumento populacional do pássaro-preto (*Agelaius ruficapillus*) na região sul do Rio Grande do Sul, Brasil. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos*. Pelotas: EMBRAPA- CPACT. 63p. (Documentos; v.39). p. 51-53

SILVA, J. J. C. da, CIRNE, M., FRANCO, D., ASMUS, M. L., MIGUENS, S., GRAVATO, C. 1997 (d). Identificação das perdas no transporte de arroz ao longo da estrada Rio Grande – Pelotas como fonte alternativa de alimentos para pássaro-preto (*Agelaius ruficapillus*), Pelotas, RS, 1997. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos*. Pelotas: EMBRAPA- CPACT. 63p. (Documentos; v.39). p. 22-25

SILVA, J. J. C. da, CIRNE, M., FRANCO, D., ASMUS, M. L., VIEIRA, M., PORTANTIOLO, R. 1997 (e). Proposta para um plano de ação para reduzir o dano causado pelo pássaro-preto à cultura do arroz irrigado no sul do Rio Grande do Sul. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos*. Pelotas: EMBRAPA- CPACT. 63p. (Documentos; v.39). p. 59-62

SILVA, J. J. C. da, CIRNE, M., FRANCO, D., ASMUS, M. L., ZONTA, P., VIEIRA, M. 1997 (f). Identificação e quantificação dos danos causados pelo pássaro-preto (*Agelaius ruficapillus*) a cultura do arroz irrigado na região sul do Rio Grande do Sul, Brasil. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos*. Pelotas: EMBRAPA-CPACT. 63p. (Documentos; v.39). p. 44-47

SILVA, J. J. C. da, FRANCO, D., ASMUS, M. L., CIRNE, M., CRUZ, W. 1997 (g). Identificação do sistema de conhecimento e informação da cultura do arroz irrigado na região sul do Rio Grande do Sul, Brasil. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos*. Pelotas: EMBRAPA- CPACT. 63p. (Documentos; v.39). p. 41-43

SILVA, J. J. C. da, FRANCO, D., CIRNE, M., ASMUS, M. L., MACEDO, C., SILVA, D. 1997 (h). Identificação de sementes encontradas junto ao resíduo do arroz colhido em Rio Grande, RS, safra 1996/97. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos*. Pelotas: EMBRAPA- CPACT. 63p. (Documentos; v.39). p. 20-21

SILVA, J. J. C. da, FRANCO, D., CIRNE, M., ASMUS, M. L., MIGUENS, S., ANTUNEZ, MS. 1997 (i). Oferta alimentar para o pássaro-preto (*Agelaius ruficapillus*) em rodovias de escoamento da safra de arroz da região sul do Rio Grande do Sul. In: REUNIÃO SOBRE O PÁSSARO-PRETO (*Agelaius ruficapillus*) E SUA INTERAÇÃO COM A CULTURA DO ARROZ NOS PAÍSES DO MERCOSUL, 1, 1997, Pelotas. *Resumos*. Pelotas: EMBRAPA-CPACT. 63p. (Documentos; v.39). p. 18-19

STONE, Charles P. 1973. Bird damage to agricultural crops in the United States; a current summary. *In:* BIRD CONTROL SEMINAR, 6, Bowling Green, Ohio, 1973. *Reprints from Proceedings.* Bowling Green, Ohio: Bowling Green State University. p. 264 - 267 [63]

STOYKE. C., WAIBEL H. 1994. A contribuition towards more sustainable farming systems. *In*: DENT, J.B. and McGREGOR (eds). *Rural and farming systems analysis*: p. 145-150

TAGLIANI, Carlos Roney Armanini. 1997. *Proposta para o manejo integrado da exploração de areia no município costeiro de Rio Grande-RS, dentro de um enfoque sistêmico*. São Leopoldo: UNISINOS. 177p.

TERRES, A. L., FAGUNDES, P. R. R., MAGALHÃES Jr., A. M. de. 1996. Cultivares de arroz irrigado – RS. *In:* MAGALHÃES JR., A.M. de, FAGUNDES, P.R.R. *Agricultura real*; arroz irrigado. Pelotas: EMBRAPA-CPACT. p.39-43. (Documentos, 20)

TEXAS AGRICULTURAL EXTENSION SERVICE. 1993. *Rice production guidelines*. Texas: The Texas A&M University Systems. [64]

TEXAS AGRICULTURAL EXTENSION SERVICE. 1997. *Rice production guidelines*. Texas: The Texas A&M University Systems. 65p.

THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT.1987. *Our common future*.Oxford: Oxford University. 400p.

TOBISSON, E. 1993. Changing roles for rural sociologists. *In*: HUDSON, N., CHEATLE. (eds). *Working with farmers for better land husbrandry*. London: Intermediate Technology Publications. p. 59 - 63

TRIPP, R., WOOLLEY, J. 1989. *The planning stage of on-farm research*: identifying factors for exparimentation. Mexico: CIMMYT and CIAT

TRONCHONI, J. G., MORAIS, A. P., NASCIMENTO, H. G. C. 1997. Diagnóstico e Perspectiva do Pré-germinado no Rio Grande do Sul. *Lavoura Arrozeira*, Porto Alegre, 50(430): 3-7

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT. 1980. *Design and evaluation of AID-assisted projects*. Washington: Training and Development Division, USAID. p. 51 – 106

VAN EŸK, T. 1998. *Farming systems research and spirituality*: An analysis of the foundations of professionalism in developing sustainable farming systems. Ph.D. thesis, Landbouwuniversiteit Wageningen, pag 44-71.

VEIGA, L.A., OLIVEIRA, A.T., GASTAL, N.A. 1995. *Aves do Taim*. Pelotas, RS : ABRAPA. p. 2 – 11 [65]

VEREIJKEN, P. 1992. A methodic way to more sustainable farming systems. *Netherlands Journal of Agricultural Science*, 40:209-223

VEREIJKEN, P. 1996. Glastuinbouw in ontwikkeling. Ph.D. thesis, Wageningen Universiteit.

VIANNA, Manoel Luiz de Souza. 1997. O desperdício de energia na irrigação do arroz. *Lavoura Arrozeira*, 50(432): 9 - 11

VIEIRA, E. F., RANGEL, S. R. S. 1984. *Rio Grande do Sul*; geografia física e vegetação. Porto Alegre: Sagra. 184p.

VIEIRA, E. F., RANGEL, S. R. S. 1985. *Rio Grande do Sul*; geografia da populacão. Porto Alegre: Sagra. 190p.

VIEIRA, E. F., RANGEL, S. R. S. 1993. *Geografia econômica do Rio Grande do Sul*; espacialidade, temporalidade na organizacão econômica rio-grandense. Porto Alegre: Sagra. 160p.

WARD, P., ZAHAVI, A. 1973. The importance of certain assemblages of birds as 'information-centres' for food-findings. *Ibis*, 115: 517-534

WEBER, E.A. 1995. *Armazenagem agrícola*. Porto Alegre: Kepler Weber industrial. 400 p.

WHITE Donald H., MITCHELL, A., KOLBE, Elizabeth J., FERGUSON, William H. 1983. Azodrin poisoning of waterfowl in rice fields in Louisiana. *J. Wildl. Dis.*, 19(4): 373 – 375 [66]

WILEY, R. Haven, MINNA S. Wiley. 1980. Spacing and timing in the nesting ecology of a tropical blackbird; comparison of populations in different environments. *Ecol. Monog.*, 50(2): 153 – 178 [67]

WILSON, E. A., GLAHN, J. F., CONSTANTINE, B. U., LeBOEUF, E. A. 1986. Feasibility of baiting blackbirds at spring roots for reducing damage to sprouting rice. *Annual Prog. Rep.*, Louisiana, 78: 86 – 90 [68]

WILSON, E. A., GLAHN, J. F., LeBOEUF, E. A. 1988. Potential nontarget hazards associated with the use of toxic baits for controlling blackbirds in Southwestern. *Annual Prog. Rep.*, Louisiana, 80 : 159 – 162 [69]

WILSON, E. A., GLAHN, J. F., LeFEBVRE, P. W., HARPER, G. A., LeBOEUF, E. A. 1988. Staging-area baiting with DRC-2698 (CAT) for controlling roosting blackbirds associated with damage to sprouting rice. *Annual Prog. Rep.*, Louisiana, 88: 151 – 158 [70]

WILSON, E. A., HOLLER, N. R., LeFEBVRE, P. W., MATTESON, R. E., LeBLANC, D. J., LeBOEUF, E. A. 1984. Evaluation of borderlang red for preventing blackbird damage to sprouting rice. *Annual Prog. Rep.*, Louisiana, 76: 135 – 138 [71]

WILSON, E. A., LeBLANC, D. J., LeBOEUF, E. A. 1984. Efficacy of Scare Crow for protecting sprouting rice from bird damage. *Annual Prog. Rep.*, Louisiana, 76: 132 – 134 [72]

WILSON, E. A., LeBLANC, D. J., LeBOEUF, E. A., CONSTANTIN, B. U. 1985. Borderland red for protecting sprouting rice from blackbird damage. *Annual Prog. Rep.*, Louisiana, 77: 114 - 122 [73]

WILSON, E. A., LeBOEUF, E. A., LeBLANC, D. J. 1986. Effect of two planting dates on blackbird damage to sprouting rice. *Annual Prog. Rep.*, Louisiana, 78: 83 – 85 [74]

WILSON, E. A., LeBOEUF, E. A., WEAVER, K. M., LeBLANC, D. J. 1989. Delayed seeding for reducing blackbird damage to sprouting rice in Southwestern Louisiana. *Wildl. Soc. Bull.*, 17: 165 – 171 [75]

WILSON, E. A., LeBOEUF, E. A., WEAVER, K. M., LeBLANK, D. J. 1990. The effect of planting date on blackbird damage to sprouting rice. *Louisiana Agric*, 33(3): 5 – 8 [76]

WILSON, E. A., ROBINSON, J. F., MORRIS, H. F., LeBLANC, D. J., LeBOEUF, E. A., BOYD, F. L. 1983. Effect of planting method on Mesurol-propanil interaction. *Annual Prog. Rep.*, Louisiana, 75: 163 – 167 [77]

WILSON, E. A., WEAVER, K. M., LeBOEUF, E. A. Effect to three planting dates on blackbird damage to sprouting rice. *Annual Prog. Rep.*, Louisiana, 79: 112 – 115 [78]

WILSON, Kathleen, MORREN JR., George E. G. B. 1990. *Systems approaches for improvement in agriculture and resource management.* New York: Macmillan Publishing Company. 361p.

WISKERKE, J. S. C. 1997. Zeeuwse akkerbouw tussen verandering en continuiteit; en sociologische studie naar diversiteit in landbouwbeoffening, technologie ontwikkeeling en plattelands vernicuwing. Landbouwuniversiteit, Wageningen, Studies van landbouw en platteland 25, pag 34-43.

WOOLLEY, J., TRIPP, R. 1994. Priority setting tools for research groups. *In*: MEINDERTSMA, J. D. (ed). *Setting research priorities*; towards effective farmer-oriented research. Amsterdam: Royal Tropical Institute. p. 47 - 64

WORLD BANK. 1990. *Poverty*. World development report. *In: PROMOTING economic opportunities for the poor*. Oxford: Oxford University press. Chapter 4

ZAFFARONI, Eduardo, PANIAGUA, Roger Taboada , SILVA, João Corrêa da. 1996. Análise dos sistemas de produção de arroz de pequenos e grandes produtores do Município de Arroio Grande, RS I; aspectos sócio-econômicos. *Lavoura Arrozeira*, Porto Alegre, 49(428): 19 – 24

ZAFFARONI, Eduardo, PANIAGUA, Roger Taboada , SILVA, João Corrêa da. 1997. Análise dos sistemas de produção de arroz de pequenos e grandes produtores do Município de Arroio Grande, RS II; aspectos agronômicos. *Lavoura Arrozeira*, Porto Alegre, 50(430): 18 - 22

Summary

Rice is one of the main components of the Brazilian diet. The State of Rio Grande do Sul produces approximately 4,6 millions tons per year — more than 54% of total Brazilian rice production. The average production in Southern Brazil is 5,2 tons per ha, with yields of 10 tons per ha being recorded. The rice production sector of Rio Grande do Sul is responsible for 240.000 jobs [production, industrialization and commercialization] and contributes 1,6 billion US dollar to Brazils' economy per year.

Because the Brazilian governmental have policies extinguished all subsidies and opened the country for globalization, the future of rice farmers depend exclusively on their capacity to compete with imported rice, in terms of market price/quality. If they prove incapable of overcoming this situation, an economic and social crisis caused by bankruptcy amongst rice farmers will take place in Southern Brazil. As immediate consequence of this would be an aggravation of the present exodus of rural workers into the cities. Despite small room for maneuvering, and trying to keep their level of productivity, the economic survival of farmers has a high priority at present.

Problem identification

The Blackbird (*Agelaius ruficapillus*) was a protected animal in Rio Grande do Sul. The bird however is a serious problem on rice producing farms. Its population has risen so drastically that it has become a pest. Blackbirds take freshly sown seeds and sprouts, break stems and eat ripening rice or knock it to the ground. Considering the current economic situation, control of blackbirds is of utmost priority for the Brazilian rice farmers. However, many control strategies are not legal or have been proved to be ineffective. An efficient and effective method, acceptable for farmers, environmentalists and nature conservationists, should be found. This thesis presents the challenge to manage the 'conflicting objectives and interests' between farmers and environmentalists. These conflicts result from different opinions, appreciation and definitions related to the problem and possible solutions involved. The method adopted is a result of long term research, carried out in close cooperation between rice farmers and supported by science.

Chapter 1 sets the context of the problem: detailed analysis of the meaning of rice production in Rio Grande do Sul State and the importance of a sustainable solution to the Blackbird problem. This chapter ends up with a clear description of the nature of the problem.

Chapter 2 continues by analyzing the Blackbird problem. The development of the problem in time and space, as well as relevant efforts for control undertaken so far, is studied on the basis of literature or experiences. This study outlines our problem and raises the scientific questions to be answered by research. An explanation is given as to why the research could only be done on the farms themselves, complete with all the variations, disturbances and differences in farm management. Finally, it is state that the question is not discovery-oriented, but invention-oriented, namely to find a method for sustainable and persistent control of Blackbirds in rice managed by farmers at farm level.

Chapter 3 identifies designing objectives at four levels of aggregation: crop, field, farm and region. Each level might be considered as a study in its own right. Results obtained from each of those studies are components of the ultimate solution: a sustainable control of the Blackbird in rice. The research journey was based on a series of steps which are addressed in detail on next chapters.

Chapter 4 represents the starting point of our research journey and concerns our first contact with the problem. This phase resulted in a conceptual model of the Blackbird problem which helped us to formulate research/designing objectives. An AKIS analysis of rice production system in Southern Rio Grande do Sul was also presented.

Chapter 5 presents an in-depth study of the Blackbird problem and identification of its causes. This phase integrates experiential and experimental knowledge. Insights obtained after integration gave the foundation for planning further research and future farmer management.

Chapter 6 concerns the design, discussion and adjustments of the theoretical management program by all the actors involved with the problem. The plan was initially drawn up by researchers and discussed with study groups of rice farmers. Finally, the outline plan was presented, discussed and improved on during an International meeting about the Blackbird, which involved actors connected to rice production and environmental preservation sectors in South America.

Chapter 7 concerns the implementation and dissemination of the management plan. Misunderstandings or inappropriate solutions, discovered after implementation of the management plan were considered as learning experiences. Actually, our research journey got a feedback effect.

Chapter 8 evaluates the Blackbird research project in the light of critical success factors. It also examines the implications of the research project for farmers, organizations and their staff. This research study demonstrates the power of participatory action and systems perspective in initiating and fostering changes based on sustainability. The inevitable conclusion is that for problems in complex agroecosystems, such as the Blackbird problem is, the combination of approaches — sustainability, systems, and participatory (SSP) — such as the one applied on this study is the preferred one for improving the problem situation: it has greater efficacy in these situations. Another conclusion is that the role of researcher changes from being a solver of problems to being a co-learner with the farmers as they seek to solve their problems and provide the means to find, together, the solutions. A SSP approach is relatively new (at least in Brazil) and the assumptions supporting it are still being determined. This study has exposed some of its positive and negative aspects.

Samenvatting

Rijst is het belangrijkste onderdeel van het Braziliaanse voedingspatroon. De staat Rio Grande do Sul produceert ongeveer 4,6 miljoen ton rijst per jaar. Dat is meer dan 54% van de totale rijstproductie van Brazilië. De gemiddelde productie in Zuid Brazilië bedraagt 5,2 ton per hectare. Opbrengsten van 10 ton per hectare komen voor. De rijstproductie sector van Rio Grande do Sul geeft 240.000 mensen werk, in onder meer de primaire productie, toeleverende industrie, handel en afzet. De sector draagt met 1,6 miljard Amerikaanse dollars per jaar bij aan de economie van Brazilië.

De Braziliaanse overheidsbeleid heeft alle subsidies voor de sector afgeschaft en het land geopend voor produceren voor de wereldmarkt. Daarom hangt de toekomst van boeren vooral af van hun vermogen om blijvend te concurreren met geïmporteerde rijst, in termen van prijs/kwaliteit verhoudingen. Als Zuid Braziliaanse boeren niet in staat blijken om de nieuwe situatie het hoofd te bieden, zal een economische en sociale crises, als gevolg van faillissementen op grote schaal, het resultaat zijn. Bovendien zal de trek van mensen van het platteland naar de stad nog sterker toenemen. Ondanks hun geringe mogelijkheden en ondanks hun pogingen om hun productieniveaus op peil te houden, verdient de economische overleving van de Zuid Braziliaanse boeren momenteel de hoogste prioriteit.

Probleemstelling

De Blackbird (*Agelaius ruficapillus*) was in Rio Grande do Sul een beschermd dier. Maar de vogel blijkt ook een ernstig probleem te vormen voor rijst producerende bedrijven. De populatie ervan is zo sterk toegenomen dat er thans sprake is van een plaag. Blackbirds verwijderen pas gezaaide rijst of gekiemde rijstkorrels uit de akker, breken rijst stengels, en vreten rijpende rijst uit de halm of duwen halmen op de grond. Gezien de economische situatie, verdient beheersing van vogelaantallen een zeer hoge prioriteit bij Braziliaanse boeren. Vele tot dusver toegepaste beheersingsmethoden bleken illegaal of ineffectief te zijn. Dus er was grote behoefte aan methoden die aanvaardbaar zijn voor zowel boeren als voor omgevings- en natuurbeschermers. Dit proefschrift gaat in op de uitdaging om een antwoord te vinden op de vraag hoe de spanningen tussen doelen en belangen tussen boeren enerzijds en milieu- en natuurorganisaties anderzijds, kunnen worden gekanaliseerd. De spanningen zijn het gevolg van uiteenlopende opvattingen, waarderingen en definities betreffende het probleem en de daarbij gedachte oplossingen. De methode die uiteindelijk werd aanvaard, moet worden gezien als het resultaat van langdurig onderzoek dat in nauwe samenwerking met rijstboeren en onderzoekers werd gevonden.

Hoofdstuk 1 toont de context van het probleem: een nauwkeurige analyse van de betekenis van de rijstproductie in Rio Grande do Sul, alsmede het belang van een duurzame oplossing van het Blackbird vraagstuk. Het hoofdstuk eindigt met een heldere probleemstelling.

Hoofdstuk 2 gaat dieper op het Blackbird vraagstuk in. Met behulp van de literatuur en ervaringen van boeren, wordt de ontwikkeling van het probleem in tijd en ruimte geschetst, alsmede de pogingen welke tot dusver zijn ondernomen om het probleem beheersbaar te krijgen. Uit dat onderzoek ontstond de probleemstelling die in onderhavig onderzoek ter hand moest worden genomen. Daaruit volgde de onderzoeksvraag als onderwerp voor onderzoek. Er wordt een verklaring gegeven voor het feit dat onderhavig onderzoek alleen op de bedrijven zelf kon worden uitgevoerd. Dat had een nadeel, omdat onderzoek in vivo altijd te maken krijgt met uiteenlopende variaties tussen bedrijven, verstoringen en verschillen in bedrijfsstijl. Het hoofdstuk eindigt met de conclusie dat ons onderzoek meer het karakter heeft van een uitvinding dan een ontdekking. Immers we wensen te weten hoe

boeren, binnen hun eigen bedrijf, op duurzame en definitieve wijze de populatieomvang van Blackbirds, zelf kunnen beheersen.

Hoofdstuk 3 identificeert ontwerpdoelen voor nieuwe beheersingsstrategieën op de vier aggregatieniveaus: gewas, veld, bedrijf en regio. Elk niveau kan worden gezien als een onderzoeksproject op zich zelf. De resultaten daaruit vormen onderdeel van de definitieve oplossing: een duurzame beheersing van de populatiedichtheden van Blackbirds in rijst. Het gehele onderzoek moet worden gezien als een reis door onderzoeksland, waarin de serie van stappen, elk afzonderlijk, in de hierna volgende hoofdstukken werden behandeld.

Hoofdstuk 4 laat het beginpunt zien van ons onderzoeksproces: het toont hoe de eerste confrontatie met het probleem verliep. Dat leverde ons een concept op van de manier waarop er tegen het Blackbird probleem kon worden aangekeken. Daarmee werd de formulering van onze ontwerp en onderzoeksdoelen mogelijk. Hierbij werd gebruik gemaakt van AKIS analyse methoden toegepast op rijstproducties in het Zuiden van Rio Grande do Sul.

Hoofdstuk 5 laat een diepgaand onderzoek zien betreffende het Blackbird vraagstuk. Het identificeert uiteindelijk de oorzaken van het probleem. In deze fase worden ervaring en experimentele kennis met elkaar geïntegreerd. Hierdoor ontstonden mogelijkheden om aanbevelingen te doen voor verder onderzoek enerzijds en voor gewenst bedrijfsmanagement anderzijds.

Hoofdstuk 6 betreft het ontwerp, de discussie daarover en de bijstelling van het theoretisch schema voor het management, gericht op de aanpak van het probleem, uit te voeren door de actoren die met het Blackbird probleem te maken hebben. Eerst werd het managementplan voorgelegd aan wetenschappelijke onderzoekers, die daarover in gesprek gingen en het plan verbeterden. Dat gebeurde tijdens een internationale bijeenkomst over de Blackbird. Aan de bijeenkomst werd deelgenomen door actoren uit zowel het rijstonderzoek als uit de wereld van de milieu- en natuurbescherming uit geheel Latijns Amerika.

Hoofdstuk 7 gaat over de uitvoering van en de voorlichting over het managementplan. Onjuiste interpretaties of ongeschikte toepassingswijzen, die na de implementatie van het plan in de praktijk naar voren kwamen, werden beschouwd als leermomenten. Daarmee kreeg het resultaat van ons onderzoeksproces een realistische, dat wil zeggen een door de praktijk getoetste, terugkoppeling.

Hoofdstuk 8 loopt het onderzoeksproject met betrekking tot het Blackbird vraagstuk nog eens door aan de hand van een aantal vooraf opgestelde kritische randvoorwaarden voor een blijvend succes. Het gaat ook in op de gevolgen van ons project voor boeren, instituties en hun personeel. Daaruit blijkt de grote betekenis van zowel een participatieve aanpak van problemen als van de systeem benadering, bij pogingen om blijvende veranderingen gericht op duurzaam produceren, aan te brengen. De onvermijdelijke conclusie wordt getrokken dat voor problemen betreffende complexe agroecosystemen, zoals het Blackbird vraagstuk, een combinatie van duurzaamheidstheoriën, systeemdenken en participatief handelen (DSP), zoals toegepast in onderhavig onderzoek, sterk wordt aanbevolen. We hebben vastgesteld dat zo'n aanpak effectief is. Een andere conclusie is dat de rol van onderzoeker verandert van probleemoplosser voor de vraagstukken van anderen, naar uitvindend leren samen met boeren en andere actoren. In die samenhang ontstaat er een gezamenlijk zoeken naar de aanpak van praktische problemen, naast zoeken naar de juiste middelen en wegen die bij een geïdentificeerde oplossing horen. Onze benadering vanuit duurzaamheid, systeem gericht en participatie (DSP) is betrekkelijk nieuw, in elk geval nieuw voor Brazilië. Het wordt gedragen door alle betrokken actoren in ons onderzoek worden gedeeld, omdat zij uitgangspunten en definities gezamenlijk delen. Daarom eindigt dit hoofdstuk met een kritisch overzicht van zowel de voor- als nadelen van onze methode.

Resumo

Arroz é um dos principais componentes da dieta brasileira. O estado do Rio Grande do Sul produz aproximadamente 4,6 milhões de toneladas por ano — mais de 54% da produção total brasileira. A produção média no sul do Brasil é de 5,2 toneladas por hectare, podendo alcançar 10 toneladas por hectare. O setor arrozeiro é responsável, no Rio Grande do Sul, por 240.000 empregos [produção, industrialização e comercialização] e contribui com 1,6 bilhões de dolares para a economia brasileira..

Devido aos cortes de subsidios e abertura do pais para a globalização pelo governo brasileiro, o futuro dos orizicultores dependerá exclusivamente da sua capacidade de competir, com o arroz importado, em termos de preço e qualidade. Na incapacidade de superar este desafio, é esperado uma crise economica e social no setor arrozeiro no sul do Brazil. Como consequencia imediata, espera-se o agravo do exodo de trabalhadores rurais para as cidades. Apesar das reduzidas opções, e principalmente tentando manter os niveis de produtividade, a sobrevivencia economica tem a prioridade no momento.

Identificação do problema

O pássaro-preto (*Agelaius ruficapillus*) era um animal protegido no Rio Grande do Sul. No entanto esta ave é um problema sério para a produção do arroz. A sua população cresceu tanto nos ultimos anos que agora é considerada como praga. O pássaro-preto come sementes, arranca plântulas, quebra os colmos, come e derruba os grãos maduros de arroz. Devido a situação econômica, o controle do pássaro-preto passou a receber prioridade por parte dos orizicultores brasileiros. No entanto, muitas das estratégias de controle não são permitidas legalmente, ou provaram não ser eficientes. Um método eficiente, aceito pelos agricultores, ambientalistas e conservacionistas deveria ser encontrado. Esta tese apresenta o desafio de manejar o 'conflito de objetivos e interesses' entre agricultores e ambientalistas, resultante de diferentes opiniões sobre o problema e as opções de solução. O método adotado é resultado de uma pesquisa de longo prazo desenvolvida em cooperação com os agricultores.

Capítulo 1 apresenta o problema: é feita uma análise da produção de arroz no Rio Grande do Sul e da importância de encontrar-se uma solução sustentável para o problema envolvendo o pássaro-preto. Este capítulo termina com uma clara descrição sobre a sua natureza.

Capítulo 2 continua a análise do problema no tempo e no espaço, como também, analisa os esforços mais importantes para resolve-lo, baseados em literatura e conhecimento popular. Este estudo delinea o problema e levanta as questões científicas para serem respondidas pela pesquisa. É justificado que este tipo de pesquisa deveria ser feita apenas a nível de propriedade rural, com todas as variações e perturbações caracteristicas do seu manejo. Finalmente, é apresentado que a questão não é orientada para a 'descoberta', mas para a invenção. Ainda, que é orientada para encontrar um método sustentavel, a nivel de propriedade e manejavel pelos produtore, de controle do pássaro-preto em arroz.

Capítulo 3 identifica os objetivos em quatro níveis de agregação: lavoura, ambiente, propriedade e região, sendo cada nível considerado como um estudo em si mesmo. Os resultados obtidos compõem a solução final: uma solução sustentável para controle de pássaro-preto em arroz. A jornada de pesquisa foi baseada numa série de passos que são apresentados nos capítulos seguintes.

Capítulo 4 representa o ponto de partida do processo de pesquisa e diz respeito ao nosso primeiro contato com o problema. O resultado final desta fase é a criação de um model conceitual envolvendo a questão do pássaro-preto que colaborou para formular as questões e objetivos de pesquisa. Adicionalmente, realizou-se uma análise do sistema de conhecimento e informação da cultura do arroz no sul do Rio Grande do Sul.

Capítulo 5 apresenta um estudo detalhado do problema envolvendo o pássaro-preto e identificando a sua origem. Nesta fase, são integrados o conhecimento científico e popular, que foram as bases para o planejamento da pesquisa e do plano de manejo.

Capítulo 6 abrange as questões referentes a planejamento, discussão e ajustes de um plano de manejo teórico, por todos os atores envolvidos com o problema. Inicialmente o plano foi desenvolvido pelos pesquisadores e discutido com um grupo de estudo de orizicultores. O plano final foi apresentado, discutido e aprimorado durante a reunião envolvendo atores do sistema de produção do arroz e preservação ambiental na América do Sul.

Capítulo 7 abrange as questões referentes a implantação e disseminação do plano de manejo. Os problemas e imperfeições do plano foram considerados como aprendizado. Na realidade, nesta fase, o processo de pesquisa apresenta 'feedback'.

Capítulo 8 avalia os pontos positivos e negativos do projeto de pesquisa em questão. Também, avalia as implicações desta pesquisa para os agricultores, organizações e equipes. É demonstrado o poder do trabalho participativo e do enfoque sistêmico na busca e implementação de soluções sustentaveis. A conclusão inevitável é que a combinação de enfoques — sustentabilidade, sistêmico e participatório — são indicados para resolver problemas em situações complexas, como as que caracterizam a questão envolvendo o pássaro-preto na cultura do arroz. Outra conclusão diz respeito a função dos pesquisadores, que deixam de ser 'donos da verdade' e passam, juntos com os agricultores, a procurar respostas para os problemas. Esta integração de visão sistêmica, ação participatória e busca da sustentabilidade é relativamente nova (pelo menos no Brasil), como são as idéias que a sustenta. Este estudo mostrou alguns dos seus pontos positivos e negativos.

About the author

Júlio José Centeno da Silva was born in 1956, in Rio Grande, Rio Grande do Sul, Brazil. He grew up in a farm in Piratini and studied from 1970 to 1975 at the Visconde da Graça agricultural School at Pelotas, Rio Grande do Sul State. From 1976 to 1980, he studied Agronomy in Pelotas Federal University. He obtained a MSc in Agricultural Production, at Pelotas Federal University, in 1991. In 1985, he participated in a course concerning the microbiological control of pests at the Boyce Thompson Institute and EMBRAPA. In 1995 he participated in the training program of the International Centre for development oriented Research in Agriculture (ICRA). He has worked since 1981 in EMBRAPA, as an entomologist initially in Dourados, Mato Grosso do Sul State. In 1985, he was transferred to Pelotas, as coordinator of the ecological agricultural project in EMBRAPA. However, he has been involved with pesticide legislation, ecological agriculture, and recently, with agroecosystem analysis. Since 1992, he has been a co-ordinator of the Blackbird project in Brazil. Júlio received an award in Mato Grosso do Sul, Brazil, as outstanding agronomist of the year of 1985, based on his efforts to elaborate State law about pesticide, commercialization and utilization.