



Proceedings of

The First Franco-MFLU Seminar on "Changes in Rice Production Systems and New Technological Challenges"



*Hosted by French-Upper Mekong Sub-region Academic
Cooperation Centre, Mae Fah Luang University
12-14 June, 2006, Chiang Rai, Thailand*

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**The First Franco-MFLU Seminar on
“Changes in Rice Production Systems and
New Technological Challenges”**



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Hosted by

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Mae Fah Luang University

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CIRAD (French Agricultural Research for Developing Countries)

School of Agro-Industry, Mae Fah Luang University

Preface

On June 12-14, 2006, the University of La Rochelle, the Centre for International Cooperation in Agricultural Research for Development (CIRAD), France, and the French Upper Mekong Sub-region Academic Cooperation Centre organized "The First Franco-MFLU Seminar on Changes in Rice Production Systems and New Technological Challenges" at Mae Fah Luang University, Chiang Rai, Thailand.

The papers printed in these proceedings are contributions from our invited speakers. We are very pleased to present the product of this successful seminar. We hope that the collection of works in these proceedings will be a precious primary source of knowledge for Thai researchers and the general public interested in the subject.

The organizing committee would like to express their deepest gratitude to the advisory committee from Mae Fah Luang University: Assoc. Prof. Dr. Ted Tesprateep, Vice-President for Research Affairs and Academic Services; Assoc. Prof. Nareewan Chintakanond, Vice-President for Planning and External Relation Affairs; Assoc. Prof. Dr. Orapin Phumiphamon, Dean of the School of Agro-Industry; Prof. Dr. John Keith Syers, Dean of the School of Science; Assoc. Prof. Dr. Preecha Upayokin, Director of the Centre for Academic Services; and Asst. Prof. Dr. Sunanta Fabre, Director of the French-Upper Mekong Sub-region Academic Cooperation Centre, for their kind and strong support. We are especially grateful to the invited speakers: Dr. Guy Trébuil, Prof. Karim Allaf, Prof. Ibtisam M. Kamal, Dr. Duong Thai Cong, Dr. Sabah M. Mounir, Dr. Mazen Alhaddad, and Miss Magdalena Kristiawan.

Our sincere appreciation goes to the French Embassy for the constant support and co-sponsoring of the event. We are also grateful to our sponsors from the Government offices as well as the private sector for their financial support. We thank the members of the translation committee for their contribution and effort in putting the papers into Thai and summarizing during the presentation. We also like to thank the technical committee for their enthusiasm and hard work in preparing everything for this seminar. Last but not least, our thanks go to all participants who spent their valuable time at this seminar. Without the participation and collective effort of all these mentioned, neither the seminar nor these proceedings would have materialized.

The French-Upper Mekong Sub-region Academic Cooperation Centre
at Mae Fah Luang University
November 1, 2006

The First Franco - MFLU Seminar Schedule

Day 1: Monday, June 12th, 2006

08.00 - 08.30	<i>Registration</i>
08.30 - 08.40	Report by Assist. Prof. Dr. Sunanta FABRE
08.40 - 08.50	Welcome Remark by Assoc. Prof. Dr. Ted Tesprateep; Vice – President for Research Affairs and Academic Services
08.50 - 09.00	Opening Remark by Mr. Jacques MORCOS; the representative of the French Embassy
09.30 - 10.30	Transformation of Rice production Systems in Asia (Dr. Guy Trébuil from CIRAD) Summarized by Dr. Pongmanee Thongbai – School of Science
10.30 - 10.45	<i>Coffee break</i>
10.45 - 12.00	Transformation of Rice production Systems in Asia (Continued) (Dr. Guy Trébuil from CIRAD) Summarized by Dr. Pongmanee Thongbai – School of Science
12.00 - 13.00	<i>Lunch</i>
13.00 - 14.30	- Instantaneous Process: Fundamental Approach of Thermodynamics of Instantaneous Processes (Dr. Mazen ALHADDAD from LMTAI - La Rochelle university) Summarized by Dr. Sailom Sampanvejsopha – School of Agro-Industry Mr. Prinya Wongsas – School of Agro-Industry Mr. Natthakan Rungraeng – School of Agro-Industry Dr. Sirirung Wongsakul – School of Agro-Industry Dr. Prissana Thamboon – School of Science
14.30 - 14.45	<i>Coffee break</i>
14.45 - 16.15	- Research and Industrialization of the Technology of Instantaneous Controlled Pressure Drop DIC (Prof. Karim ALLAF from LMTAI - La Rochelle university) Summarized by Assoc.Prof.Dr. Orapin Phumiphamon – School of Agro-Industry Mr. Prinya Wongsas – School of Agro-Industry Mr. Natthakan Rungraeng – School of Agro-Industry Dr. Sirirung Wongsakul – School of Agro-Industry Dr. Anant Eungwanichayapant – School of Science Dr. Prissana Thamboon – School of Science
16.15 - 17.45	- Swell-steaming and Parboiling of Rice by DIC Technology (Dr. Duong Thai Cong from LMTAI - La Rochelle university) Summarized by Assoc.Prof.Dr. Orapin Phumiphamon – School of Agro-Industry Mr. Prinya Wongsas – School of Agro-Industry Dr. Anant Eungwanichayapant – School of Science
17.45 - 18.15	Meeting with Prof. ALLAF and Mrs. BLASCO (Ta Sud Room, AD Building)
18.30 - 20.30	Welcome dinner hosted by the French Embassy (Teak Garden Spa Resort) MC: Mr. Apichit Euariyakul – School of Law Miss Orapin Riyaprao – School of Science

Day 2: Tuesday, June 13th, 2006

08.30 - 09.00	<i>Registration</i>
09.00 - 10.30	<i>- Companion Modeling for Collective Management of Renewable Resources in South-East Asia (Dr. Guy Trébuil from CIRAD) Summarized by Dr. Pongmanee Thongbai – School of Science</i>
10.30 - 10.45	<i>Coffee break</i>
10.45 - 12.00	<i>- Companion Modeling for Collective Management of Renewable Resources in South-East Asia (Continued) (Dr. Guy Trébuil from CIRAD) Summarized by Dr. Pongmanee Thongbai – School of Science</i>
12.00 - 13.00	<i>Lunch</i>
13.00 - 14.30	<i>Application of DIC Technology to Agro-industry: Solids Materials - New Swell-spray-drying for Texturing Powder: Case of Milk Powder (Dr. Sabah M. MOUNIR from LMTAI - La Rochelle university) Summarized by Dr. Suthee Wattanasiriwech – School of Science Dr. Darunee Wattanasiriwech – School of Science</i>
14.30 - 15.00	<i>Coffee break</i>
15.00 - 16.00	<i>- Contribution of DIC to the technologies of cut fresh fruits and vegetables (Prof. Ibtisam M. KAMAL and Dr. Sabah M. MOUNIR from LMTAI - La Rochelle university) Summarized by Dr. Suthee Wattanasiriwech – School of Science Dr. Darunee Wattanasiriwech – School of Science</i>
16.15 - 17.15	<i>Meeting with Prof. ALLAF and Mrs. BLASCO (Ta Sud Room, AD Building)</i>
18.30 - 20.30	<i>Dinner hosted by Mae Fah Luang University (Teak Garden Spa Resort)</i>
	<i>MC: Mr. Apichit Euariyakul – School of Law Dr. Prapassorn Damrongkool – School of Science</i>

Day 3: Wednesday, June 14th, 2006

08.30 - 09.00	<i>Registration</i>
09.00 - 10.00	Application of DIC Technology to Agro-industry: fruits and vegetables · The New Method of Swell-drying of Fruits and Vegetables (Prof. Karim ALLAF from LMTAI - La Rochelle university) Summarized by Assoc.Prof.Dr. Orapin Phumiphamon – School of Agro-Industry Miss Niramol Suntipabvivattana – School of Agro-Industry Miss Saowapa Chaiwong – School of Agro-Industry Dr. Anant Eungwanichayapant – School of Science Dr. Prissana Thamboon – School of Science
10.00 - 10.15	<i>Coffee break</i>
10.15 - 11.15	· Swell Instantaneous Extraction of Essential Oils: Case of Ylang Ylang Flowers (Miss Magdalena KRISTIAWAN from LMTAI - La Rochelle university) Summarized by Dr. Suwanna Deachathai – School of Science Dr. Sayamrat Panpoom – School of Science
11.15 - 11.45	Meeting with Prof. ALLAF and Mrs. BLASCO (Ta Sud Room, AD Building)
11.45 - 12.00	Closing Remark by Assoc. Prof. Dr. Ted Tesprateep; Vice - President for Research Affairs and Academic Services
12.00 - 13.00	<i>Lunch</i>
13.00 - 18.00	Excursions: Factory visit: Fruit/ Vegetable/ Flower Drying Products. Tea industry visit: Doi Mae Salong MC: Mr. Apichit Euariyakul – School of Law Dr. Phunrawie Sroisuwana – School of Science

Rapport du 1^{er} séminaire Franco- MFLU:

« Changes in Rice Production Systems and New Technological Challenges »

Organisé par le Centre Franco-Haut Mékong de Coopération Académique

Avec le soutien de l'Ambassade de France à Bangkok

12 – 14 Juin 2006

Changes in rice production systems and new technological challenges

Les 12, 13 et 14 juin, a eu lieu à Mae Fah Luang University, le premier séminaire sur les « Changes in Rice Production Systems and New Technological Challenges », organisé par le French-GMS Centre de Coopération Académique, et animé par Mr Trébuil, chercheur au CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le développement), et Mr Allaf et son équipe venus de l'université de La Rochelle, composée de Mr Al Haddad, Mr Cong, Mme Kamal- Mustapha, Mlle Kristiawan et Mlle Mounir. Environ quatre-vingt participants ont assisté aux diverses présentations, non seulement des professeurs et des étudiants en sciences ou en chimie, mais aussi des chercheurs et des hommes d'affaires venus de toute la Thaïlande.

Présenté par Mr Trébuil, le sujet « Transformation of Rice production Systems in Asia » a montré les changements dans la production rizicole au cours des cinquante dernières années en Asie, depuis la « révolution verte » à la fin de années 50 à nos jours et les divers enjeux socio-économiques auxquels les pays asiatiques doivent faire face tels que l'augmentation de la population, le respect de l'environnement, le partage des ressources renouvelables telles que l'eau et la terre, etc...

Dans un deuxième exposé, Mr Trébuil a présenté le « Companion Modeling for Collective Management of Renewable Resources in South-East-Asia » (ComMod). Cette approche basée sur des cycles de type : jeux de rôles → confrontation → discussions, permet de :

- comprendre un système complexe d'interactions
- faciliter la gestion collective des ressources renouvelables

Le ComMod a été mis en place en Thaïlande, notamment dans le village de Mae Salep où les riziculteurs doivent faire face à l'érosion du sol. Ainsi les chercheurs du CIRAD ont permis d'amorcer le dialogue entre les différents acteurs impliqués afin de trouver une solution commune à ce problème.

L'équipe de Mr Allaf, après une longue période d'études et de recherches, a réussi à élaborer un large secteur d'applications de la nouvelle technologie de Détente Instantanée Contrôlée (DIC, brevet Allaf88), qui consiste à faire subir aux produits un traitement couplé mécanique et thermique de type HTST (High Temperature-Short Time). Ce procédé qui comporte les quatre étapes suivantes :

- mise sous vide
- injection de la vapeur
- détente instantanée vers le vide
- remise à la pression atmosphérique

est à la base de tous les autres procédés tels que :

- 1- Swell-steaming and parboiling of rice by DIC Technology
- 2- New Swell-spray-drying for texturing powder: case of milk powder
- 3- Swell-decontamination of powders and solids
- 4- Swell instantaneous Extraction of Essential Oils: case of Ylang-ylang flowers
- 5- Instantaneous Controlled Drop DIC

Mais avant l'explication des procédés ci-dessus par ses collègues, le doctorant Mr Al Haddad a exposé l' « Instantaneous Process: Fundamental Approach of Thermodynamics of Instantaneous Processes » durant lequel il a expliqué et prouvé dans le cas de quelques phénomènes thermodynamiques de l'analyse théoriques

spécifiques aux phénomènes d'instantanéité (approches synthétiques étudiées et proposés par Mr Allaf en 2002)). De nouvelles lois de la thermodynamique d'instantanéité sont ainsi établies.

1- "Swell-steaming and parboiling of rice by DIC Technology", présenté par Dr.Cong. Dans le cas de l'étuvage thermo-mécanique par DIC du riz Paddy, la Détente Instantanée Contrôlée permet de réaliser l'étuvage du riz couplé à une micro-alvéolation parfaitement contrôlée. Les résultats, par rapport aux traitements d'étuvage classique, montrent une amélioration notable de la qualité du riz : durée de cuisson réduite et maîtrisée à volonté, grains plus fermes et non collants, préservation du contenu aromatique...

2- "New Swell-spray-drying for texturing powder: case of milk powder", présenté par la doctorante Mlle Mounir.

La déshydratation/texturation est une nouvelle méthode de séchage de produits. Le procédé consiste à faire subir aux produits une succession de cycles, chacun formé de deux étapes principales :

- mise sous haute pression et attente d'un certain temps : D_{ph}
- détente rapide ($<1/100s$) vers le vide et attente d'un certain temps D_{pb}

C'est lors de cette détente vers le vide que se produit une modification de la structure du produit et l'élimination par auto-vaporisation d'une partie de l'eau contenue dans le produit, et dans ce cas dans le lait en poudre.

3- "Swell-decontamination of powders and solids", co-présenté par la doctorante Mlle Mounir et le Dr.Kamal-Mustapha

La débactérisation/stérilisation et l'enrobage par DIC permet une maîtrise de la stérilisation et de la pasteurisation des produits alimentaires en morceaux ou pulvérulents et une grande préservation de la qualité (couleur, texture) d'une part, et d'autre part des contenus organoleptiques et vitaminiques grâce au refroidissement instantané. De plus, la DIC arrête immédiatement toute réaction thermique et enzymatique, cause essentielle d'altération.

4- "Swell instantaneous Extraction of Essential Oils: case of Ylang-ylang flowers", présenté par la doctorante Mlle Kristiawan.



L'huile essentielle d'Ylang-Ylang, très odorante et peu coûteuse, a de nombreux intérêts commerciaux, notamment en parfumerie, et nombreux sont les parfums à base d'huile essentielle d'Ylang-Ylang. Le procédé d'extraction de l'huile essentielle par DIC, à partir de fleurs séchées (comme pour la fleur d'Ylang-Ylang) ou fraîchement cueillies, est aussi adapté pour les secteurs de la cosmétique et pharmaceutique car l'extraction par DIC ne nécessite pas l'utilisation de solvants et a l'avantage d'être rapide et sélective pour une qualité d'huile supérieure par rapport à d'autres

procédés de distillation et une consommation d'énergie nettement inférieure

5- "Instantaneous Controlled Drop DIC", présenté par Prof.Allaf.

Le séchage et la texturation des fruits et légumes est le seul procédé capable de coupler haute qualité et faible coût. Effectivement, les résultats montrent que la

qualité des produits séchés par DIC (préservation de la forme, de la couleur, de la saveur, des vitamines) est nettement supérieure comparée aux produits séchés par air chaud ou lyophilisés, et qu'au niveau des coûts, les séchage par DIC se révèle moins onéreux.

Dans le cadre du Laboratoire Maîtrise des Technologies Agro-Industrielles (LMTAI), présidé par Mr Allaf, huit thèses de doctorants y ont été soutenues, quatre projets européens de transfert ont été accordés et réalisés, plus de quarante contrats industriels ont abouti à la définition de l'utilisation de la DIC dans plus d'une centaine de produits ; de plus le LMTAI accueille des stagiaires et des doctorants venus du monde entier qui permet un brassage de cultures et un transfert de savoirs.

Conclusion :

Ce séminaire a rencontré un vif succès auprès de tous les participants, et on peut en tirer un bilan plutôt positif :

- au niveau de l'université Mae Fah Luang, l'achat d'une machine de Détente Instantanée Contrôlée est envisagé afin de permettre une coopération des recherches scientifiques avec l'équipe de Mr Allaf,
- au niveau académique, l'échange d'étudiants doctorants et post-doctorants va se mettre en place très rapidement entre l'université Mae Fah Luang et l'université La Rochelle
- enfin, au niveau du secteur privé, les directeurs de coopératives et d'entreprises présents au séminaire ont été très intéressés par ce transfert de connaissance, et ont manifesté le désir de rester en contact avec le French-GMS Centre afin de se tenir au courant de l'évolution de la technologie DIC.

Quant à Mr Allaf et son équipe, ils ont été enchantés par l'accueil qui leur a été réservé et impressionnés par l'organisation tout au long du séminaire.

Contents

Preface	i
Day 1 Program	ii
Day 2 Program	iii
Day 3 Program	iv
Rapport du 1 ^{er} séminaire Franco- MFLU	v
Recent Transformations of Rice Systems in Asia: Research Impact <i>Trébuil, G.</i>	1
Companion Modelling (ComMod) for Collective Renewable Resource Management <i>Trébuil, G.</i>	38
Companion Modelling to Support Adaptive Land Management in an AKha village of Northern Thailand <i>Barnaud, C., Trébuil, G., Bousquet, F.</i>	55
Our Companion Modelling Approach <i>Barreteau, O. and others</i>	68
Technology of Instantaneous Controlled Pressure-Drop (DIC®) <i>Allaf, K.</i>	75
Impact of DIC® Texture Modification on Drying Kinetics and Final Product Quality <i>Allaf, K., and Ghiaus, A.G.</i>	109
Thermodynamics of Instantaneous Process <i>Alhaddad, M., Sobolik, V., and Allaf, K.</i>	117
DIC in the operation of Steaming & Parboiling of Rice <i>Duong, T.C., Lefèvre, L., Haba, A.</i>	121
Is it possible to control the texture of powder particles during spray drying? Impact of Instantaneous Controlled Pressure Drop (DIC) <i>Mounir, S., Allaf, K.</i>	129
New Tendencies in Preservation of Fruits and Vegetables by Drying and by Edible Coatings <i>Kamal, I.M., Mounir, S., and Allaf, K.</i>	142
Super Instantaneous Extraction of Essential Oils: Case of Ylang Ylang Flowers <i>Kristiawan, M., Sobolik, V., and Allaf, K.</i>	150
Appendix	173

Recent Transformation of Rice Systems in Asia: Research Impact

Guy Trébuil

Cirad, Management of renewable resources & environment research unit,
Montpellier, France

and

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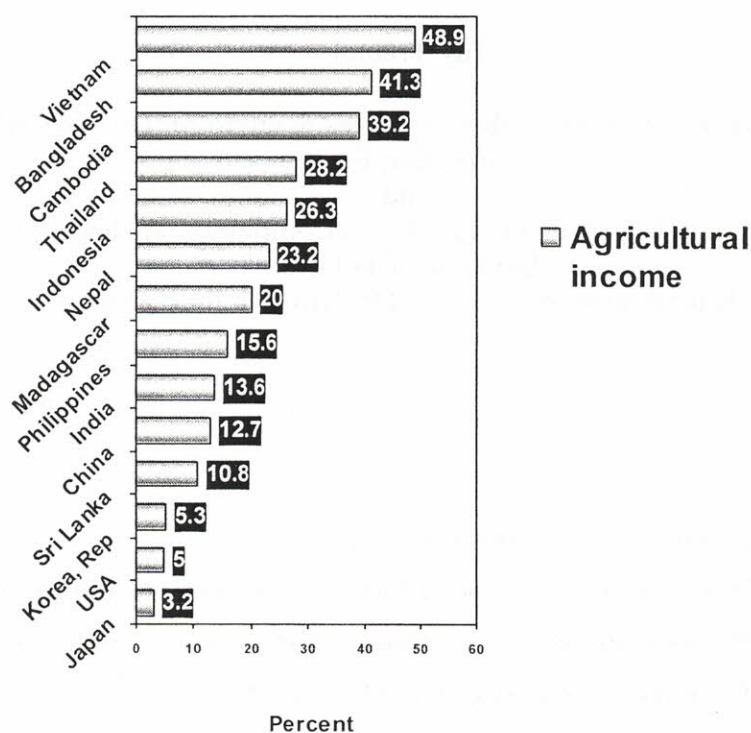
Contents

- ❖ The strategic role of rice systems in Asia
- ❖ A review of the Green revolution in Rice: nature, success and limits
- ❖ The main rice ecosystems of Asia: characteristics & key problems
- ❖ Diversity of rice issues in post-green revolution era
- ❖ Implications for rice research
- ❖ Consequences on the organization of rice research
- ❖ Rice stakes at the beginning of the 21st century
- ❖ Conclusions: conditions for success

Strategic Role of Rice Systems in Asia (1)

- ❖ Rice production= 1st human economic activity in the world (2.2 billion in Asia)
 - 150 million ha (15% global FA), 90% in Asia
 - Staple grain for 60% of the population
 - 200 million of small rice farms in Asia:
 - Size: from 0.4 ha in China to 4 ha in Thailand
 - 50% of total production for household consumption
 - Annual consumption white rice per capita:
From 75 kg in India to > 200 kg in Burma
 - The paddy field = 1st employer in Asia, multiple products

Rice share of agricultural income



Net rice trade status, selected Asian countries, 1905-2001

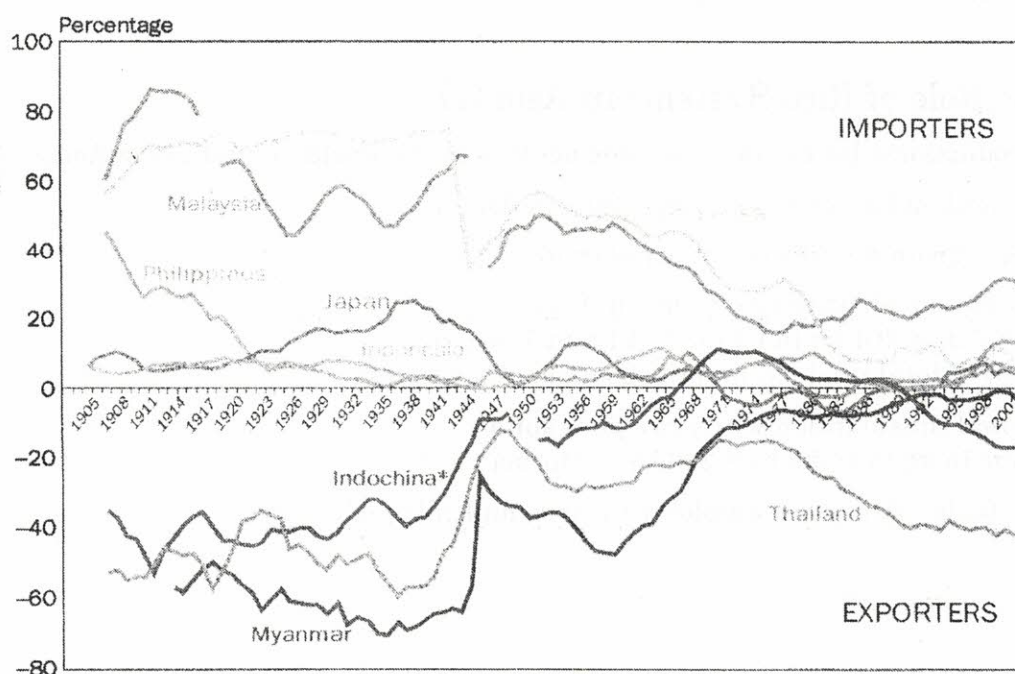


Fig. 2. Net trade status, selected Asian countries, 1905-2001.

Note: The values shown are 5 year moving averages to smooth year-to-year fluctuations. When imports exceed exports (+), net trade status is expressed as a % of consumption. When exports exceed imports (-), net trade status is expressed as a % of production. This convention avoids reporting values exceeding 100%. Gaps reflect unavailable data.

*Indochina includes Vietnam, Cambodia and Laos until 1949 and Vietnam and Cambodia from 1951, with trends in Vietnam dominating in both periods.

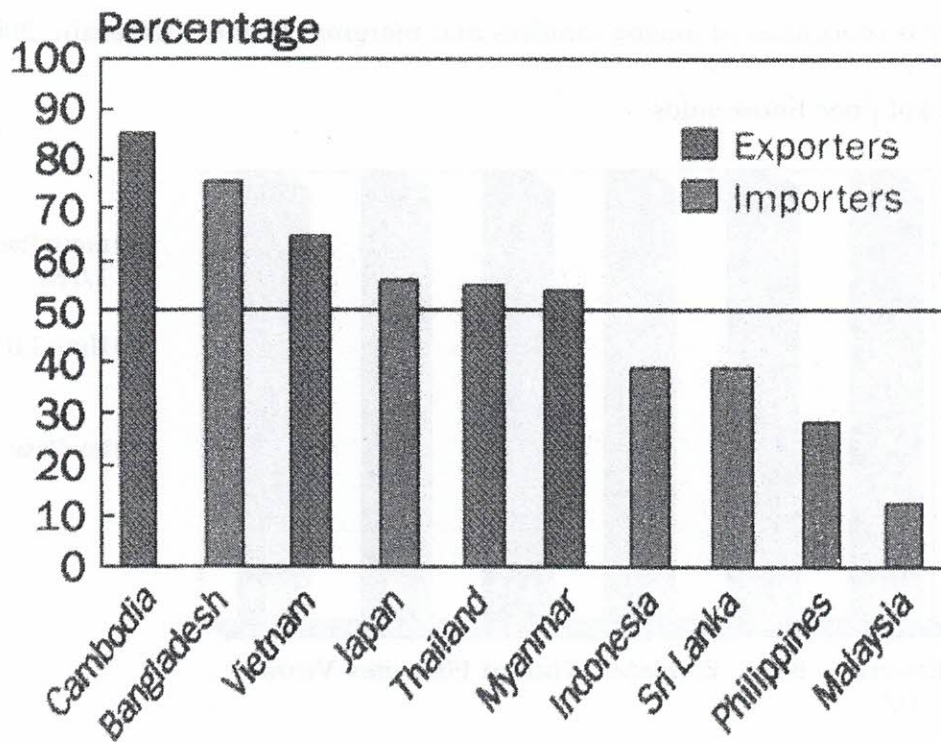


Fig. 1. Share crop area planted to rice, selected Asian countries, 1990-2001. Data: FAO.

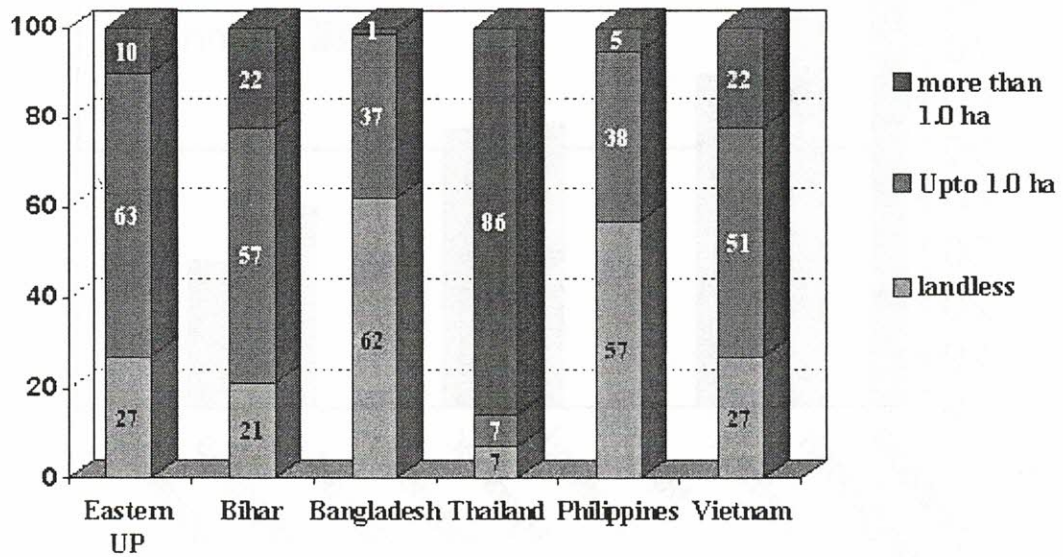
Strategic Role of Rice Systems in Asia (2)

❖ Rice & poverty in Asia

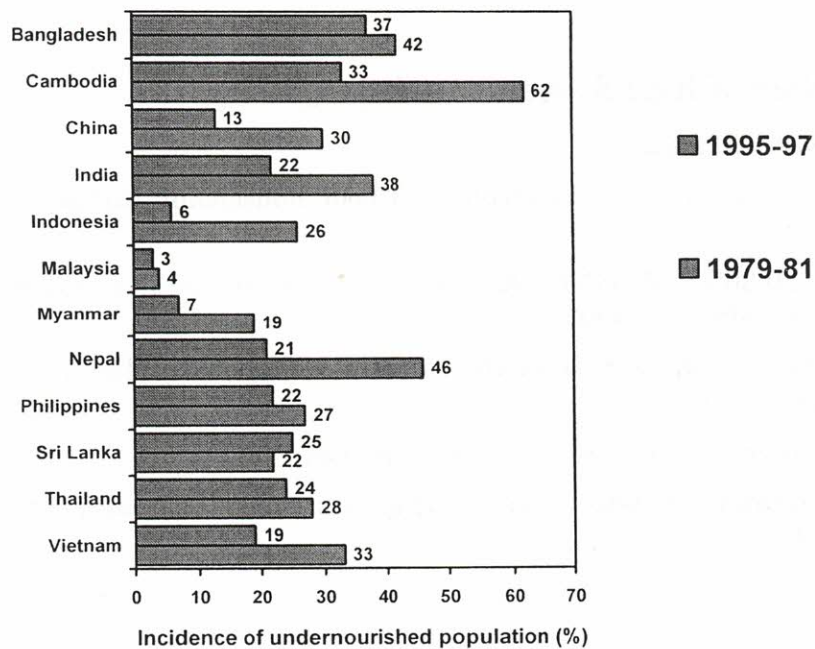
- Rice= 50 to 70% of cash incomes of poor households (urban areas, landless farmers)
- Rice= 20-30% of GNP & 30-50% of farm added value if average income/inhabitant <500\$
- Rice= Provide up to 60% of the calories & 30-60% of the proteins by poorer households
- Rice growers, low prices & low cash incomes
- *Food security in Asia= Rice security first! (Ex. Indonesia, the Philippines, China?)*

Poverty is concentrated among landless and marginal farmers (Hossain, 2003)

Share (%) of poor households



Incidence of undernourished population, selected countries in Asia (Hossain, 2003)





NEWS ITEM: LAST YEAR'S GAINS IN THAI STOCKMARKET FAIL TO REACH THE COUNTRYSIDE.

Noo/Bangkok Post

Strategic Role of Rice Systems in Asia (3)

❖ Rice & politics in Asia

- A very narrow world market (6-7%) & giant consumers (China, India, Indonesia, etc.)
- Affordable rice= political & social stability
- Stability of the domestic price: often still a political priority
- An essential cultural role for centuries
- *Rice systems: a crucial sector to mitigate poverty and to promote agricultural development*

Ratio of rice exports to domestic production, 1950-2000

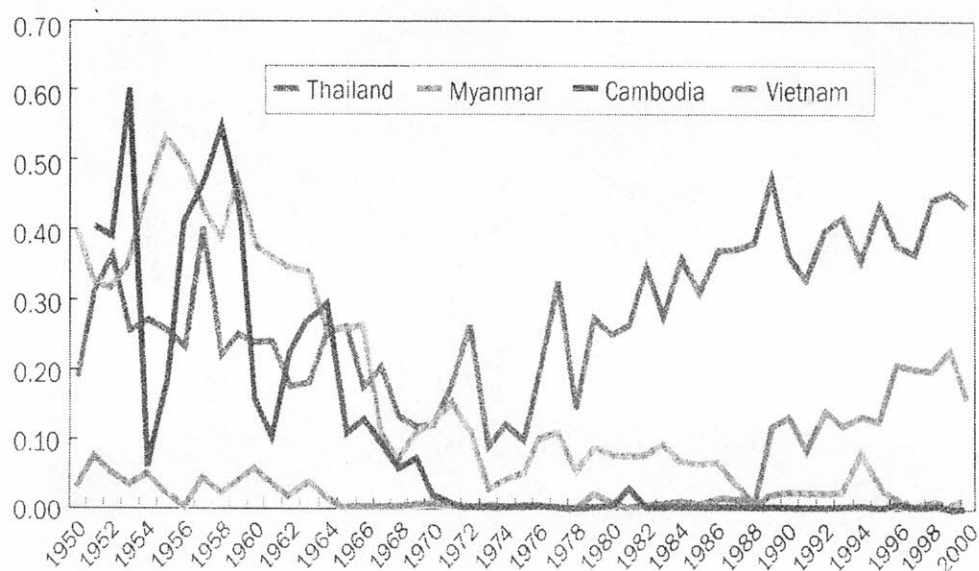
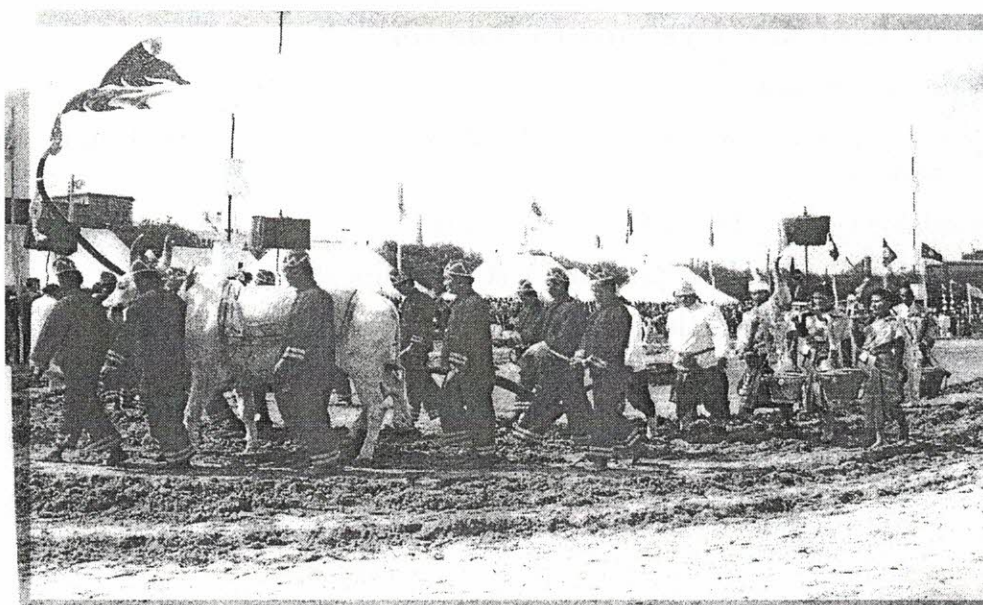
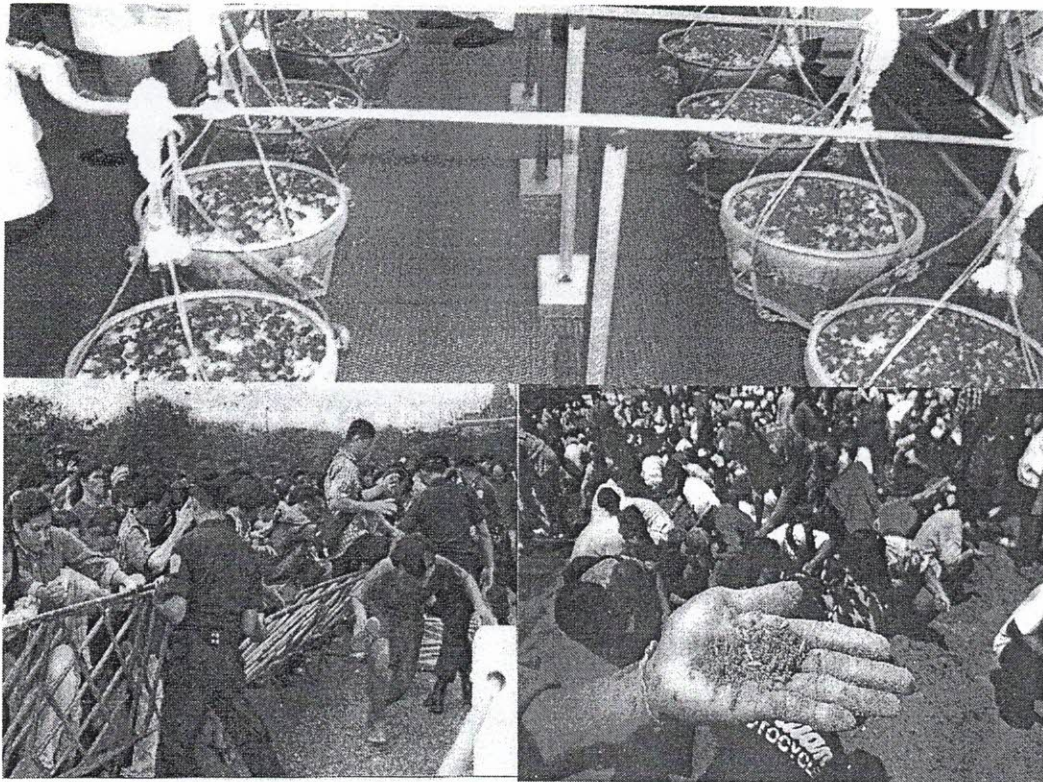
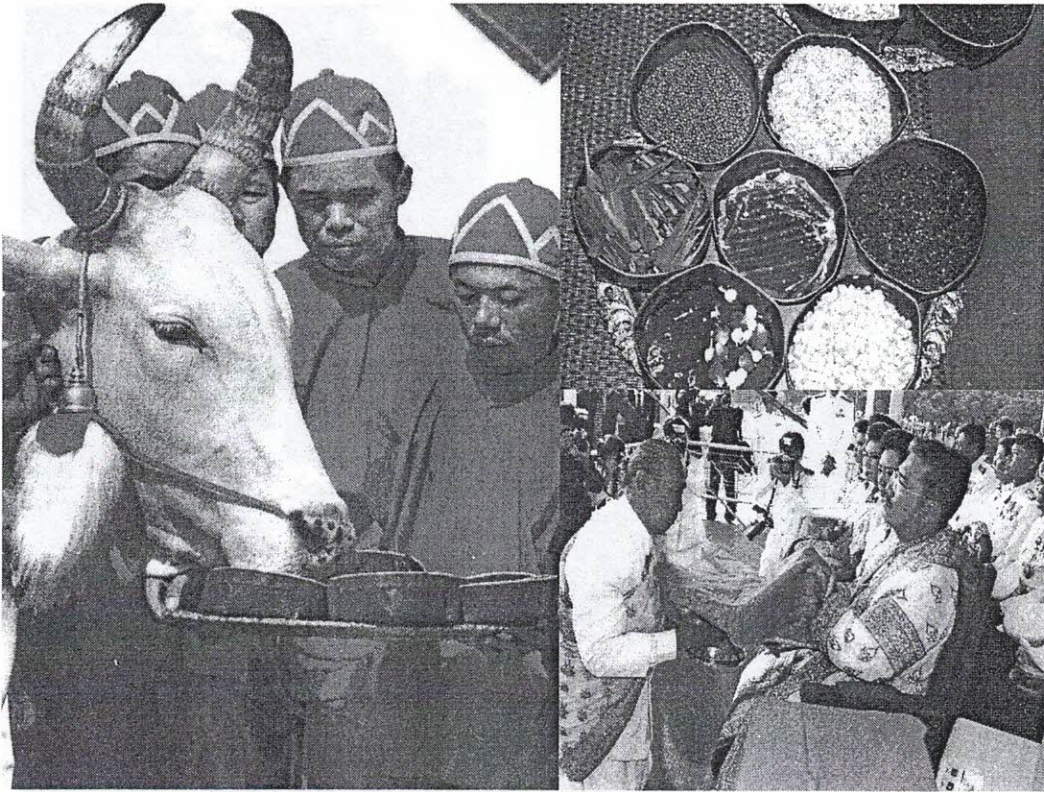
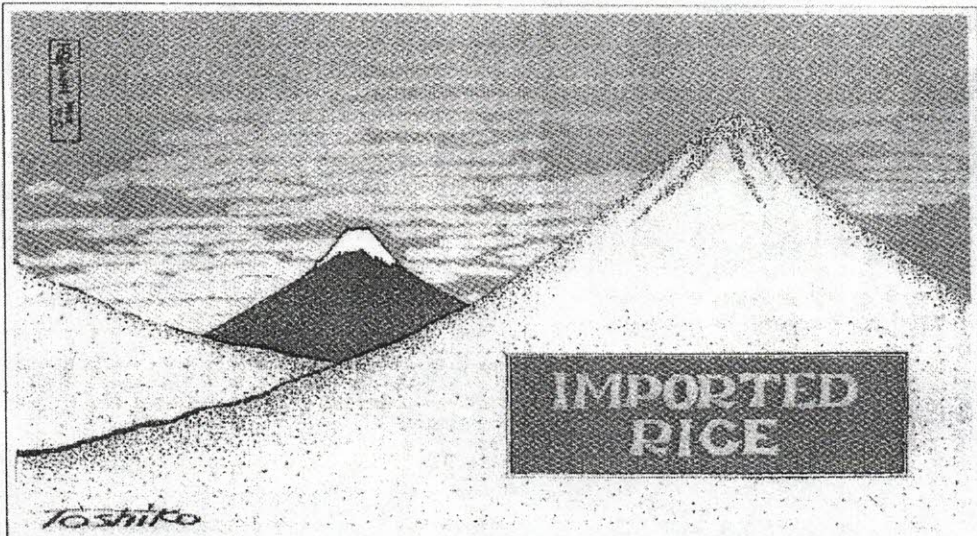
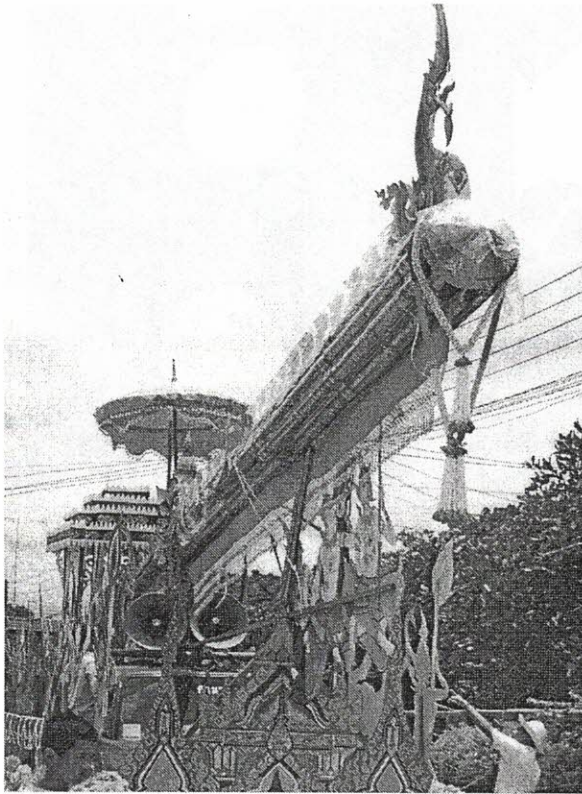


Fig. 2. Ratio of exports to domestic production, 1950-2000: Thailand, Myanmar, Cambodia and Vietnam.







NEWS ITEM: Japanese consumers like the lower prices of foreign rice.

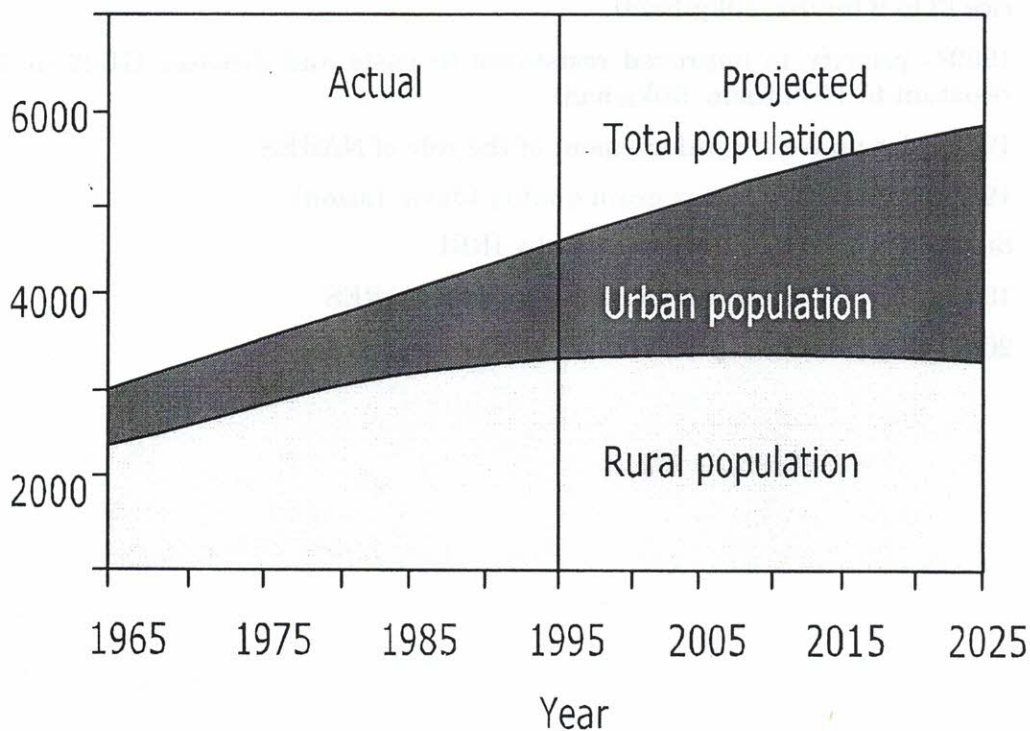
Toshiko Nishida/The Nikkei Weekly

The rice stake at continental level

- ❖ 70% of the poor & malnourished are Asians
 - 50% of them are in South Asia (> Sub-Saharan Africa)
- ❖ Rate of population growth: 1.7% per year
 - = 50 million new consumers every year
- ❖ Need to increase production volume by 25%
 - From 520 (in 1998) to 650 million tons in 2020
- ❖ Decrease in farm land /inhabitant
 - From 0.15 ha in 1995 to 0.09 ha in 2025
- ❖ Rapid urbanisation and social risks
 - More than 100 million farm workers on the road in China!

Projected population and urbanization in Asia

Population (million)



Source: United Nations, 1998. World Urbanization Prospects: The 1996 Revision.

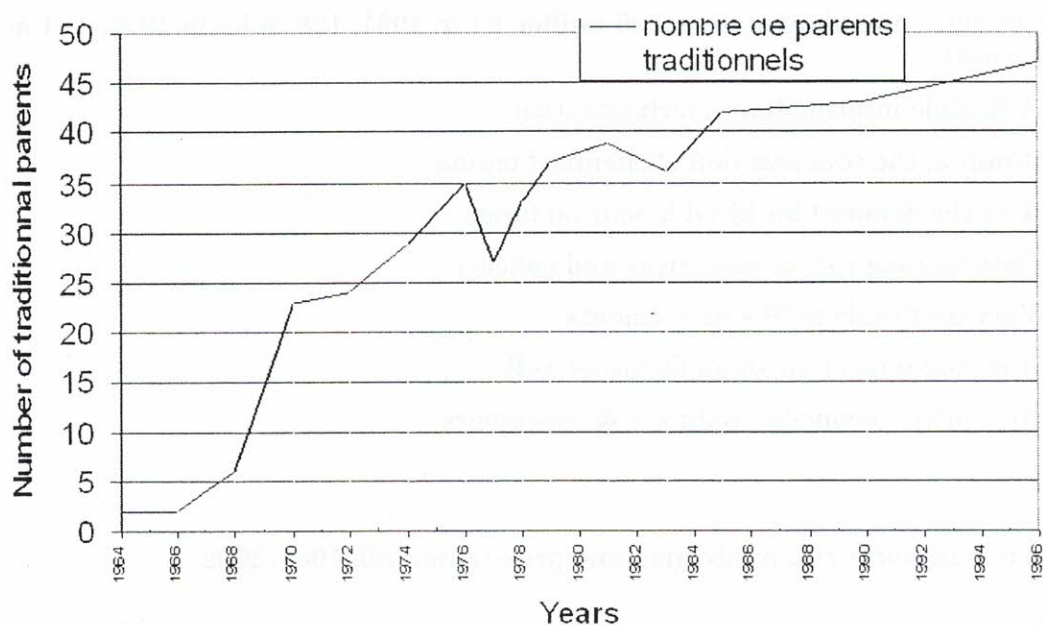
The Green Revolution in rice: Origins

- ❖ The late 50s: a determining geopolitical context
 - Tensions: China, India, Pakistan, Vietnam, Indonesia
 - Explosion of population growth
 - Several consecutive years of bad harvests
 - New orientation of international aid
 - *Urgent to increase rice productivity / demand*
- ❖ 1960: Creation of IRRI at Los Baños, Philippines
 - Advances in Japan, China, Taiwan
 - Initial mission initial: to raise the rice yield potential in the humid tropics of Asia

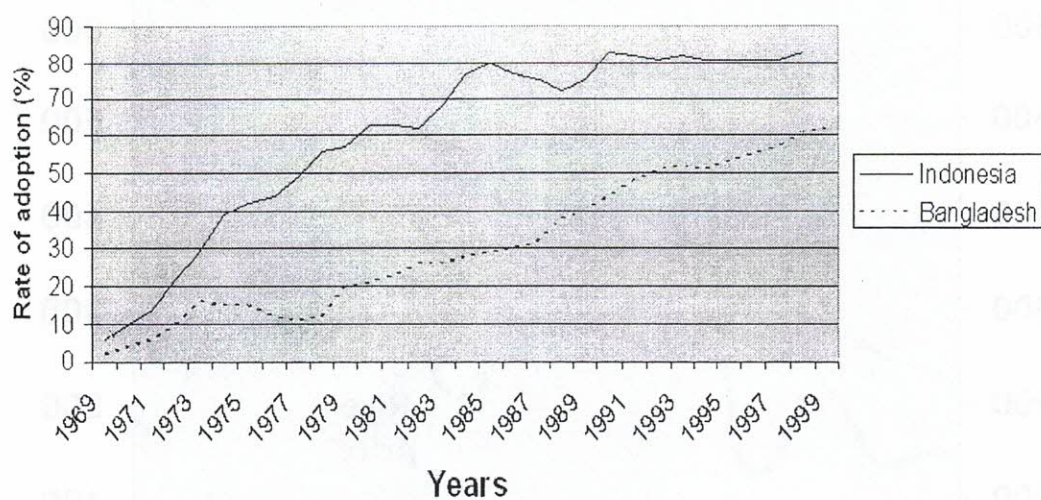
The Green Revolution in rice: main technological content

- ❖ Creation of semi-dwarf indicas varieties
 - 1965= major qualitative jump: tripling of physical productivity in irrigated rice (3 to 9 ton/ha, 70kg/ha/d)
 - 1969+: priority to improved resistance to pests and diseases (IR36 in 1976: resistant to 16 of them, 90kg/ha/j)
 - 1975+: 1st phase of reinforcement of the role of NARES
 - 1985: IR 64 with a better grain quality (Java, Luzon)
 - Since IR8: 225 lines disseminated by IRRI
 - 1962-1991: 1741 new varieties released by NARES
 - 2000: they are planted on 70% of the rice area in Asia

Number of traditional rice parents used in breeding semi-dwarf varieties:
1964-1996



Rate of adoption of semi-dwarf varieties, Indonesia & Bangladesh

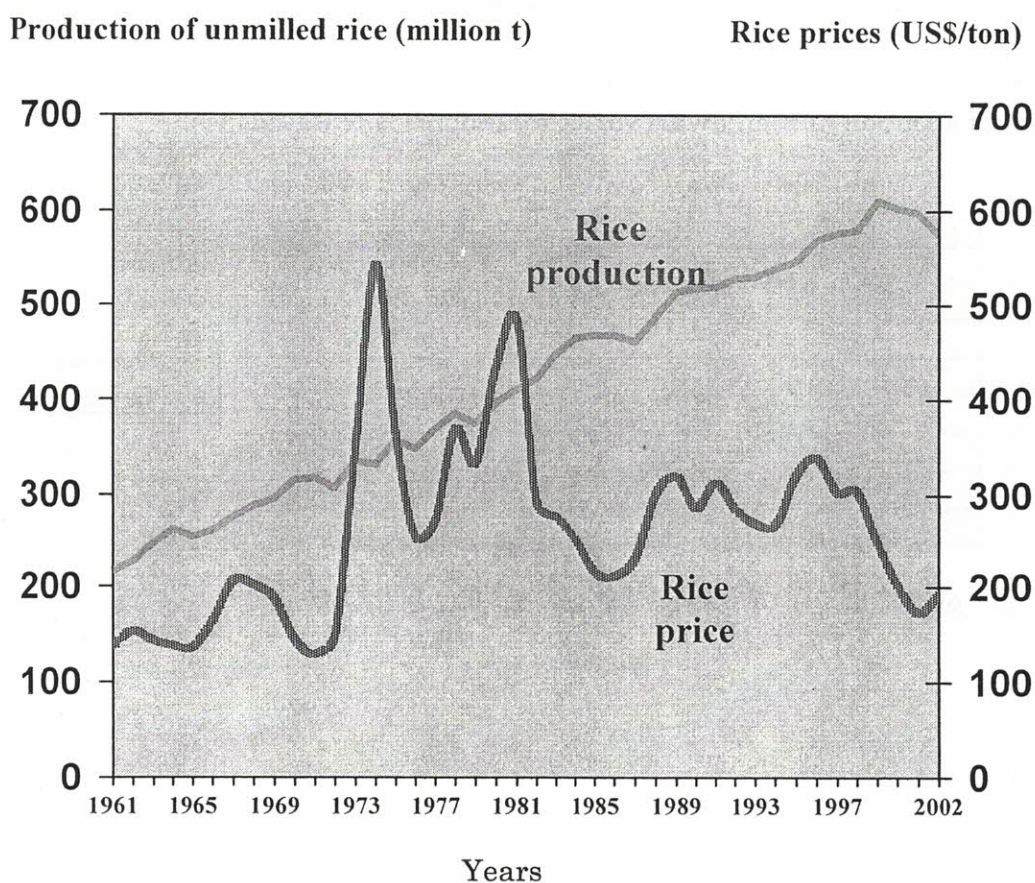


The Green Revolution in rice: Major achievements

❖ An impressive jump of the production

- On plateauing planted areas: 96 million ha in 1951, 128 m ha in 1975, 134 m ha recently
- A flexible intermediary mechanization
- Jump in the consumption of chemical inputs
- & of the demand for hired labour on farms
- Determining role of incentives and policies
- Very profitable publis investments
- A strong impact on small farms as well
- Rice price: reconcile producers & consumers

Trends in world rice production and price (nominal), 1961-2002



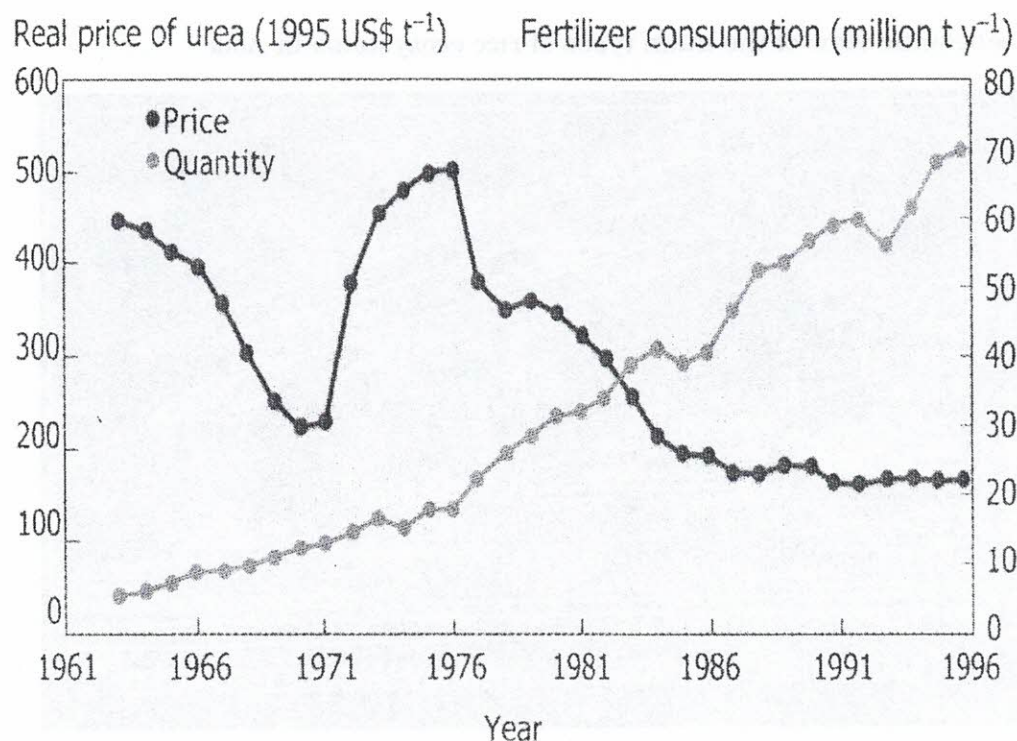


Figure 1. Relationship between world prize of urea and total fertilizer consumption in Asia, 1961-96.

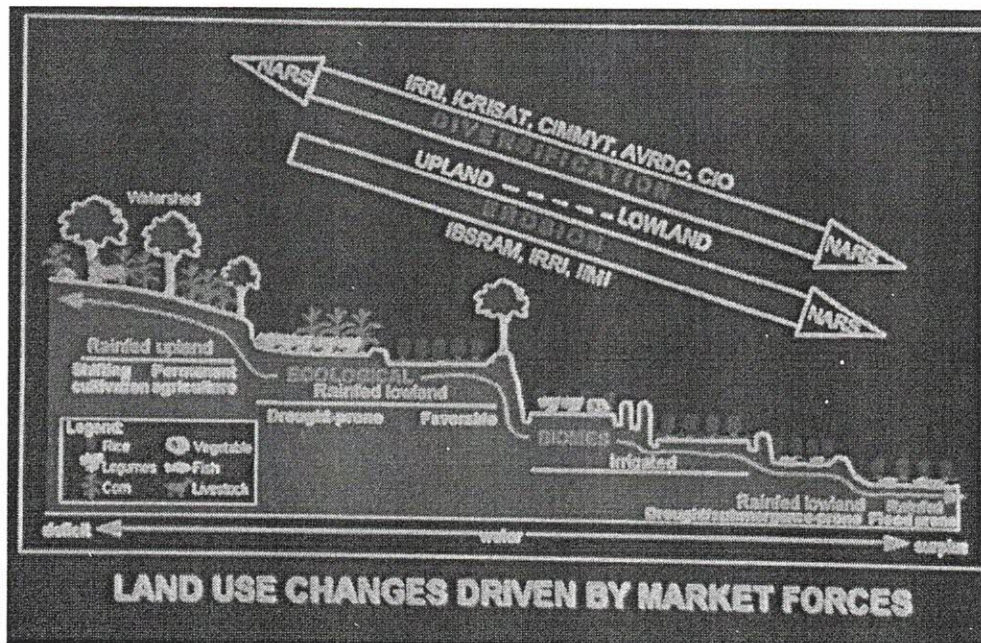
The Green Revolution in rice: limits & unequal benefits

- ❖ A geographically very unequal rice development model
 - Water control is necessary: non-irrigated rice ecosystems are by-passed by the Green Rev.
 - Huge disparities among countries & regions
 - Important environmental externalities
 - Degradation of irrigated soils: drainage, salinisation
 - Nitrogen fertilization & quality of surface water
 - Negative effects of insecticides, farmers' health, etc.

Main rice ecosystems in Asia

- ❖ Characterization
 - Key role of surface hydrology:
 - Level of control over time
 - Depth and duration of flood water
 - A simple typology: 4 main ecosystems
 - Irrigated: 55% of the rice FA, 75% of the production
 - Rainfed lowlands: 25% F.A., 18% of the production
 - Upland: 12% FA, 4% of the production
 - Deep water and coastal: 8% F.A., 3% of production

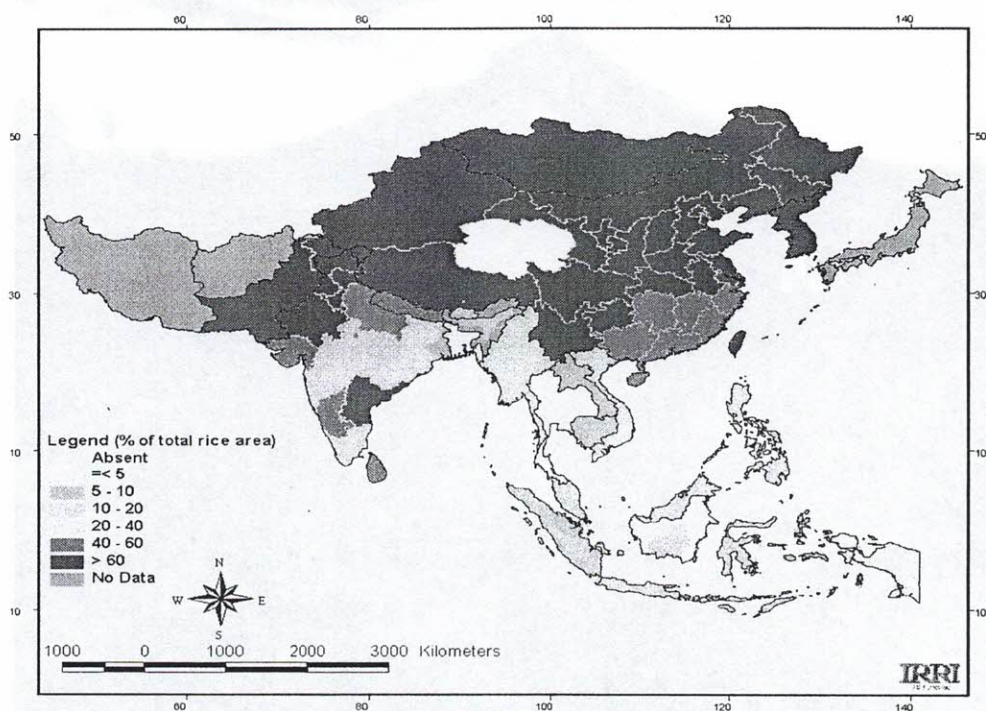
A schematic view of the main types of rice ecosystems in Asia



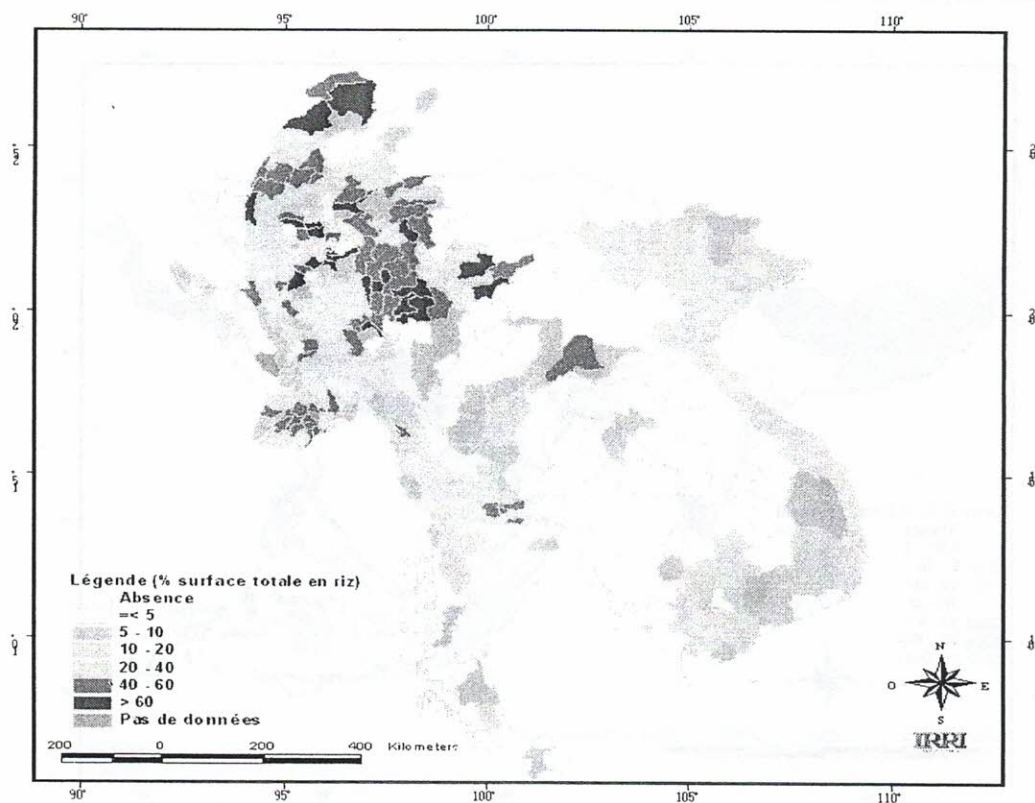
Irrigated rice ecosystem: better water control



Distribution of wet season irrigated rice production in the humid tropics and sub-tropics of Asia

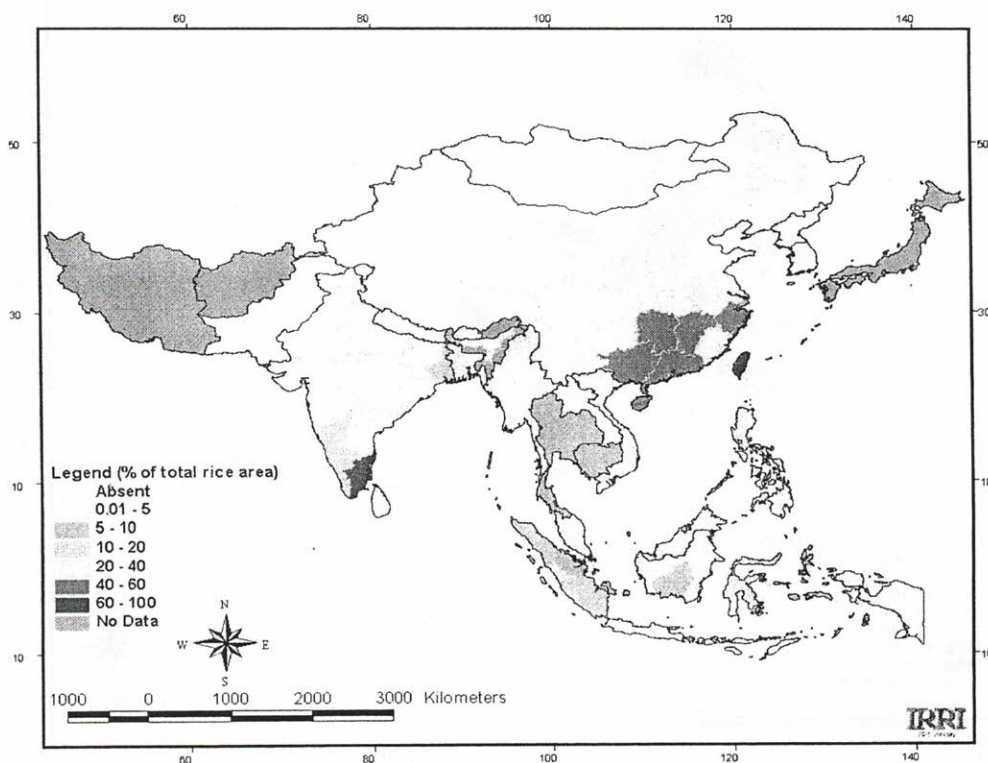


IR Wet season

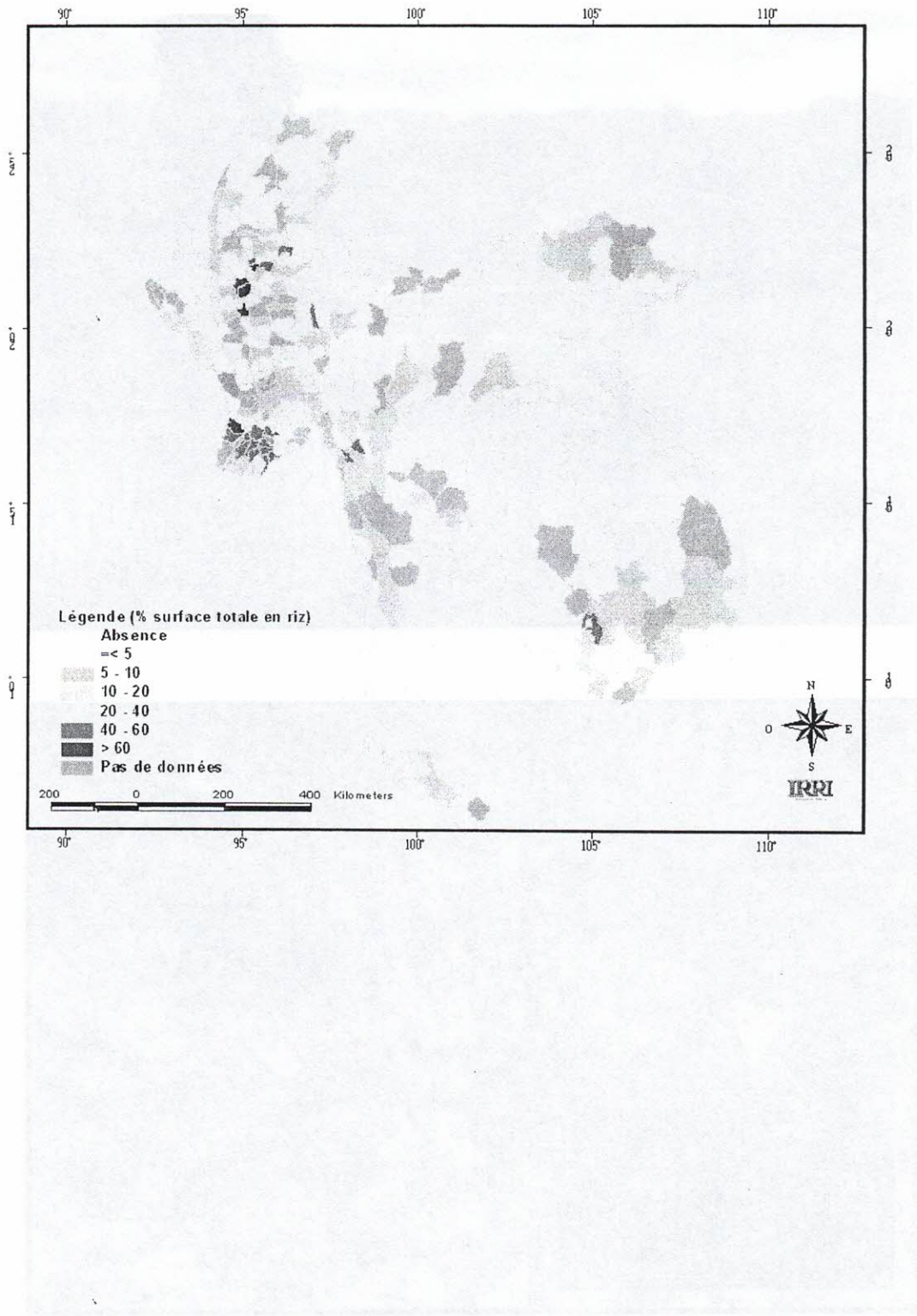




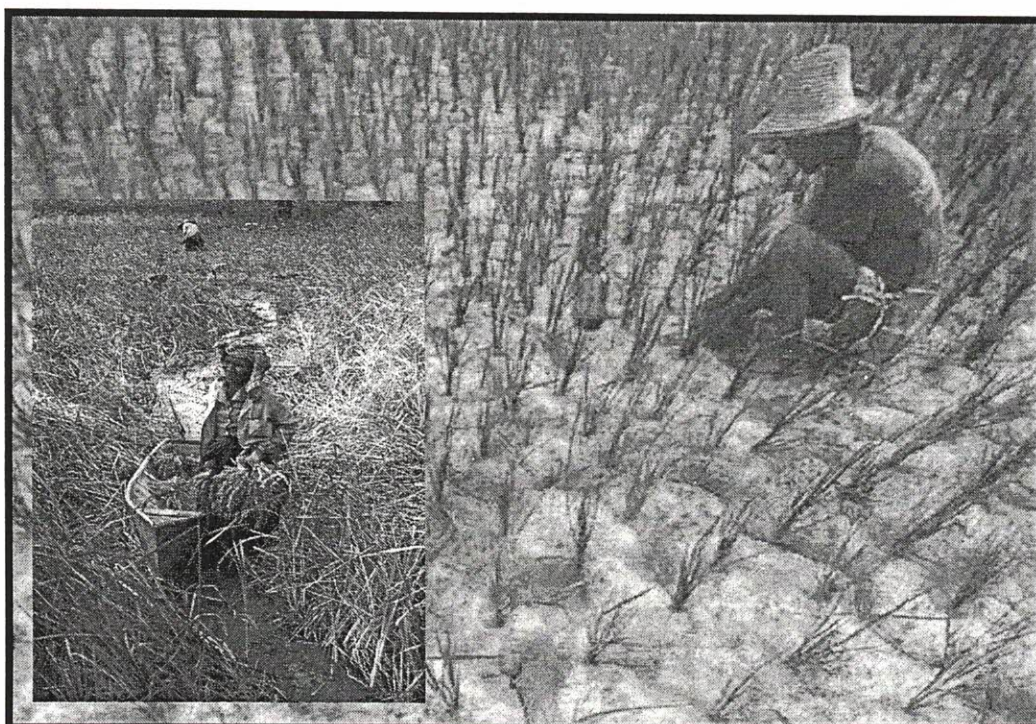
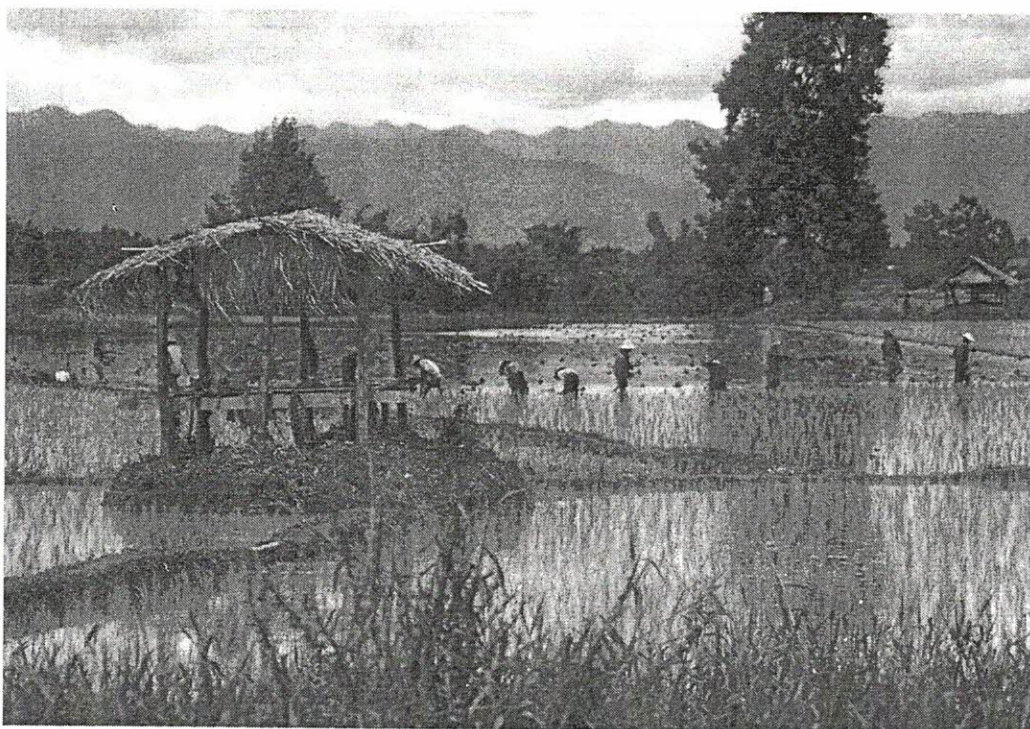
Distribution of dry season irrigated rice production in the humid tropics and sub-tropics of Asia



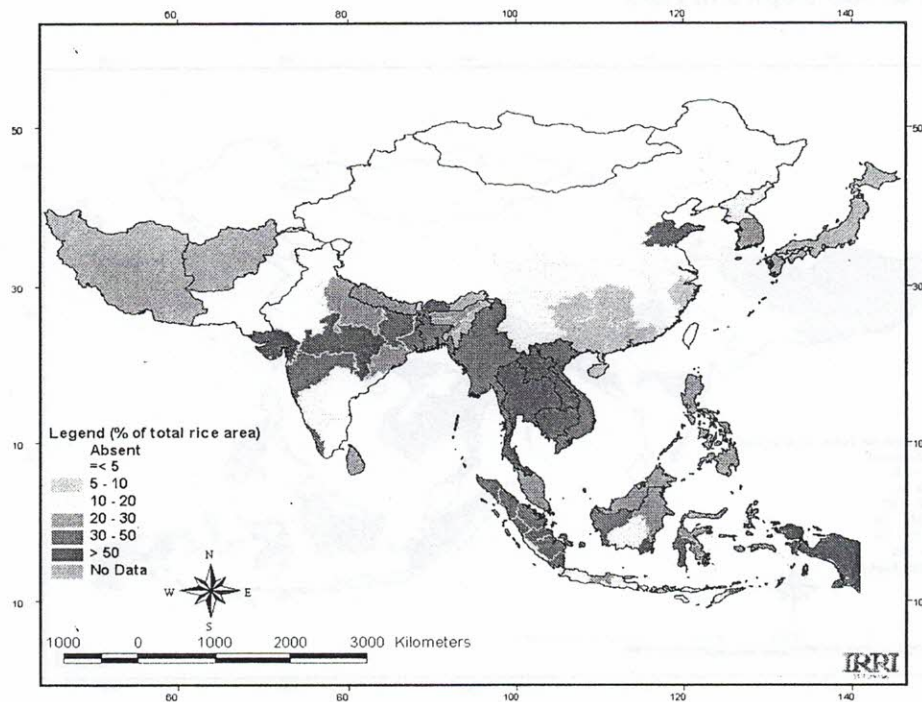
IR Dry season



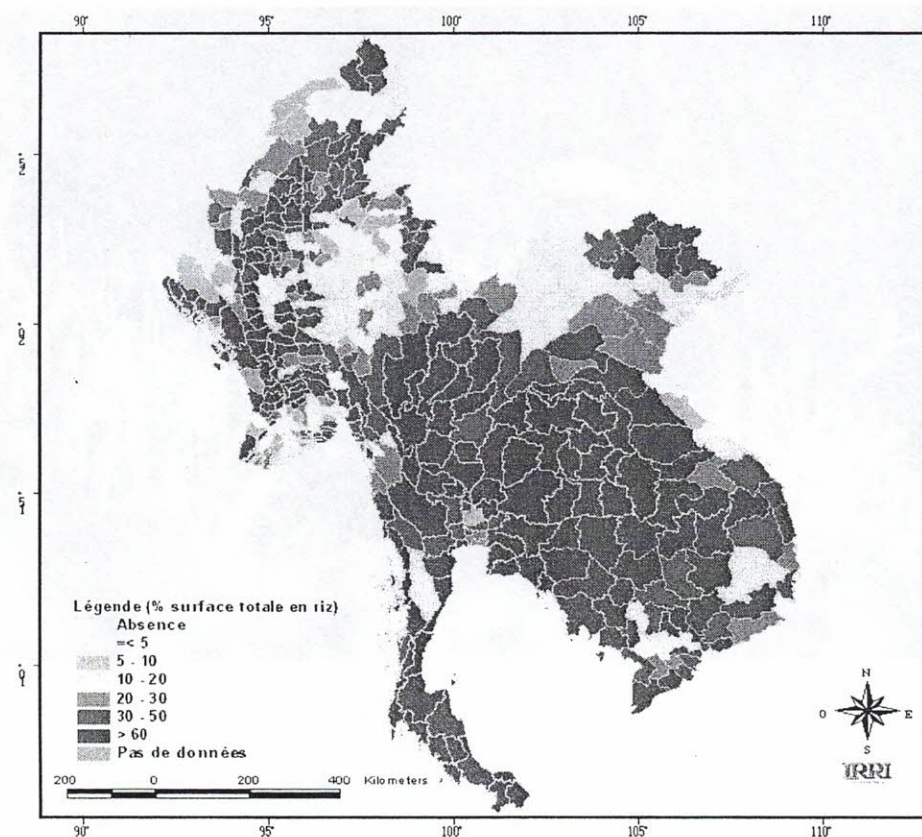
Transplanting rainfed lowland rice in Laos



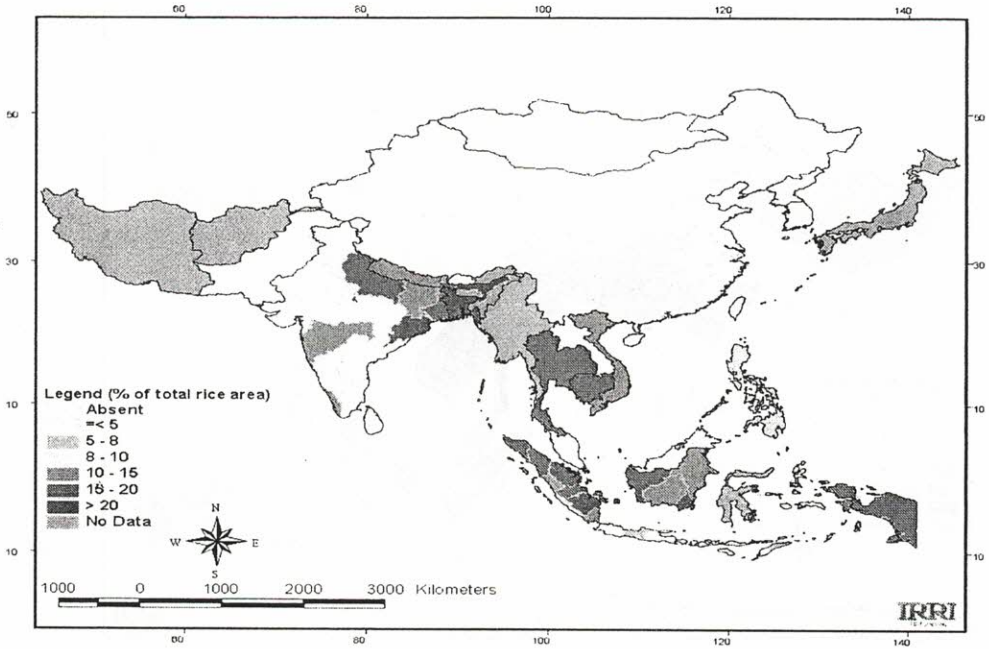
Distribution of shallow rainfed lowland rice production in the humid tropics & sub-tropics of Asia



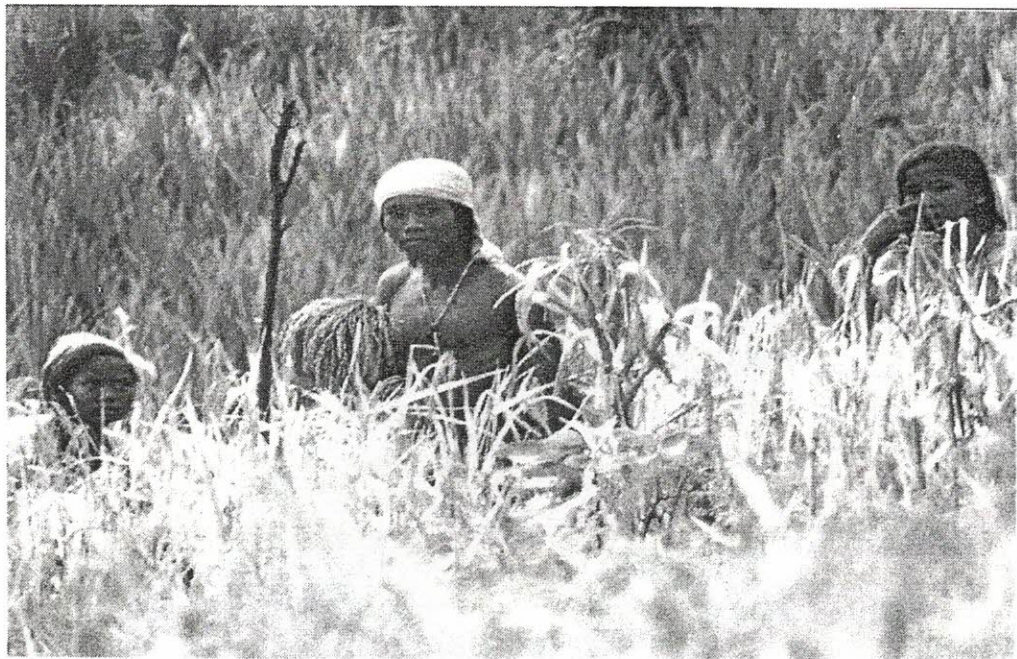
RLR Shallow



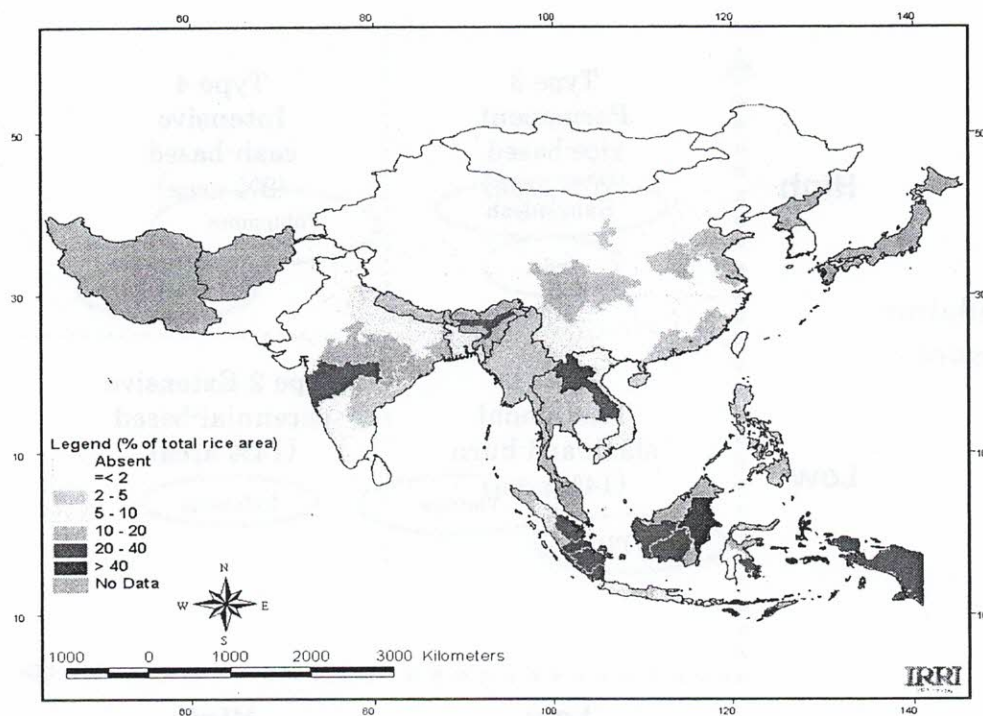
Distribution of intermediary rainfed lowland rice production in the humid tropics & sub-tropics of Asia



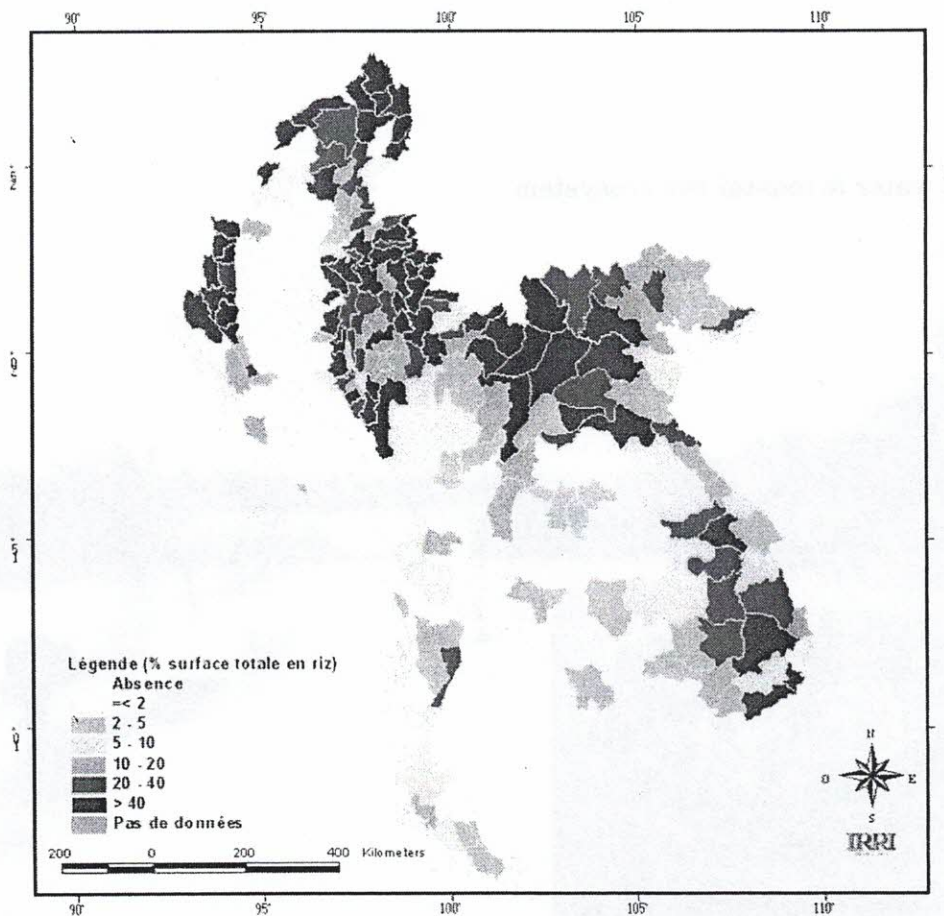
Harvesting upland rice in Papua New Guinea



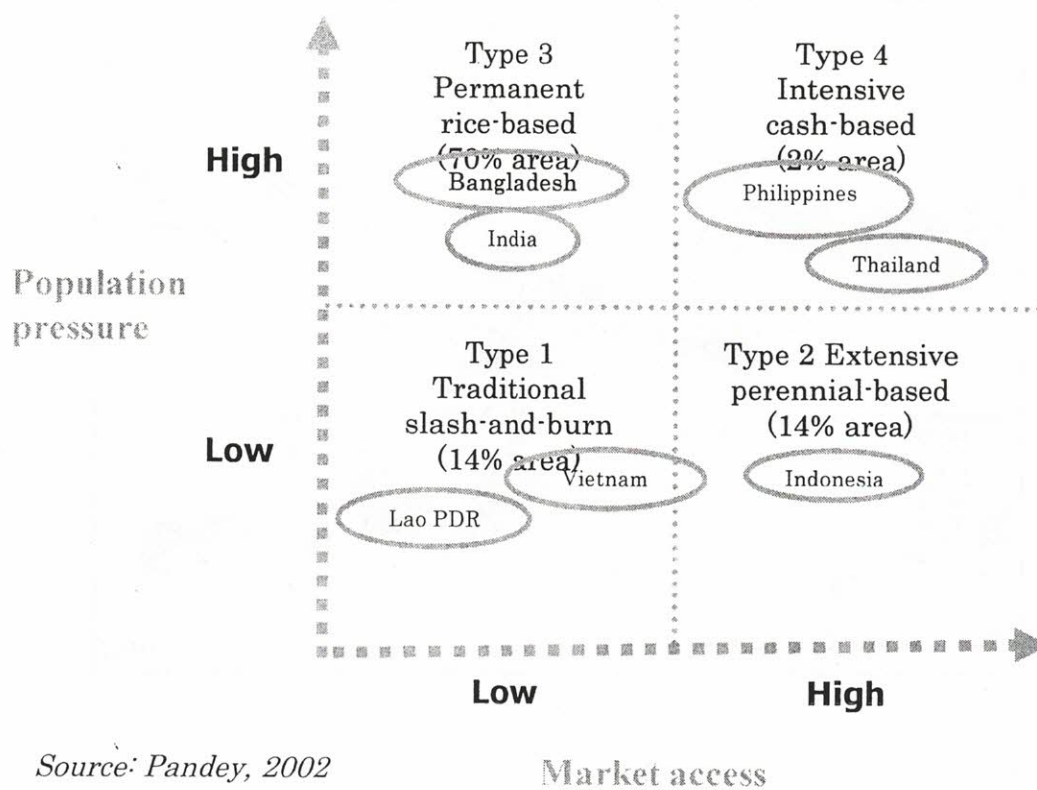
Distribution of upland rice production areas in the humid tropics & sub-tropics of Asia



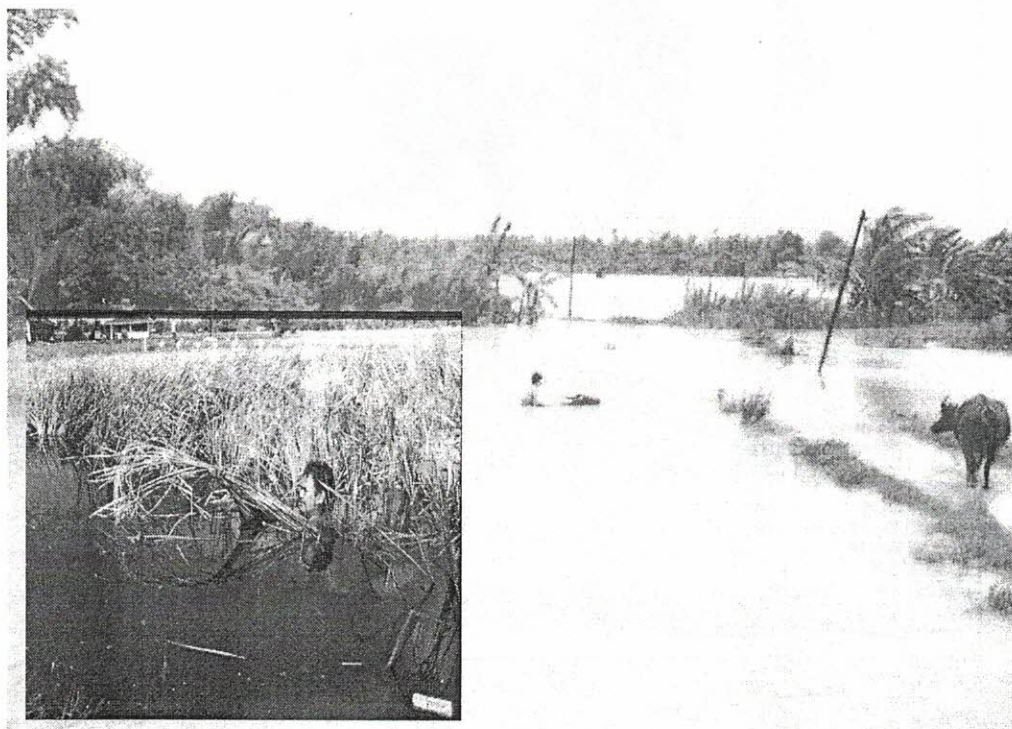
UR



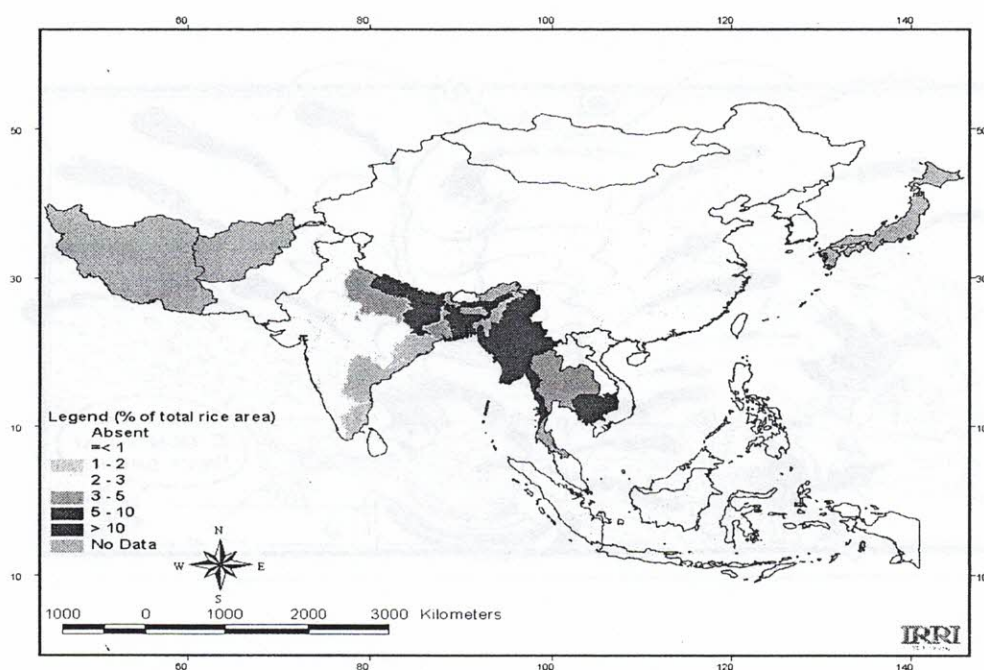
Typology of uplands in SE Asia



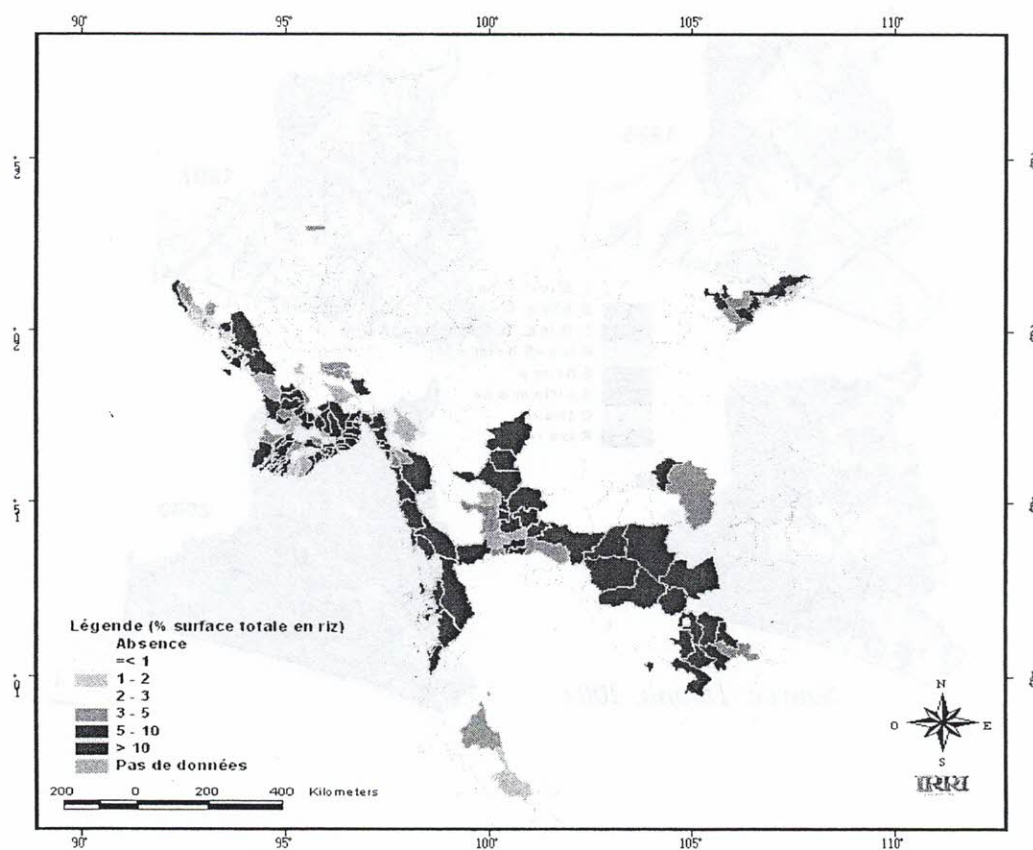
Deep water & coastal rice ecosystem



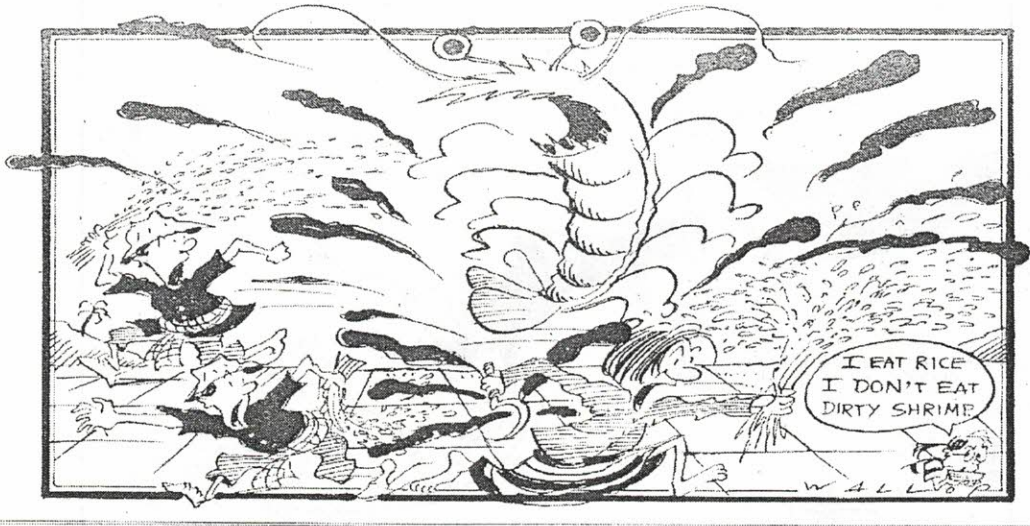
Distribution of deep water and coastal rice production in the humid tropics & sub-tropics of Asia



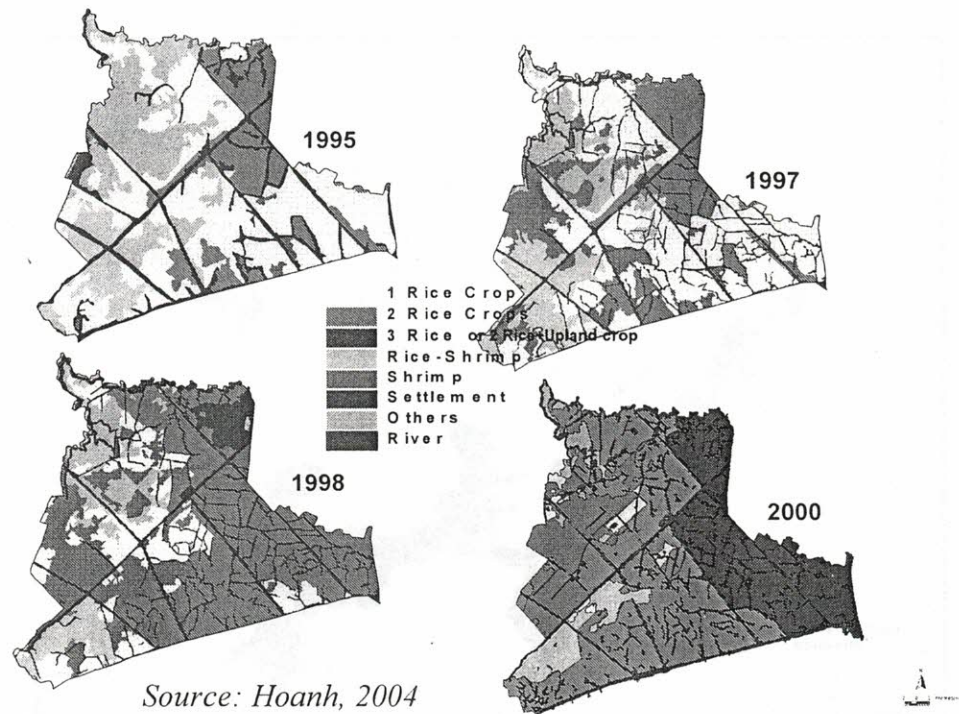
DWR



Expansion of shrimp farming is a source of conflict in coastal rice areas of SE Asia



Bac Lieu Province, Mekong delta

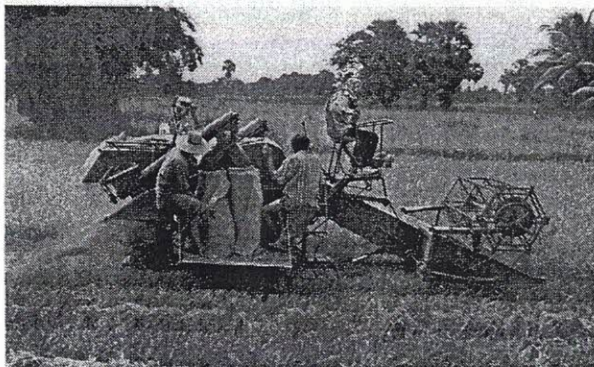


Diversity of post-green revolution issues & problematiques (1)

- ❖ The turning point of the mid 80s
 - Main producers have achieved self-sufficiency in rice
 - Maximum expansion of planted areas, before decline
 - Decreasing growth rate of rice yields in irrigated areas
 - Changes in national economic policies & priorities of international aid
 - Beginning of a decade of double digit economic growth in several countries
 - Mutations in labour markets, labour migrations
 - Increased crop diversification out of rice
- ❖ Case of irrigated rice (IR)
 - Less farm land
 - Less labour
 - Less water
 - Less (chemical) inputs
 - More international competition on a narrow world market
- ❖ *But the main « rice bowls » remain crucial*

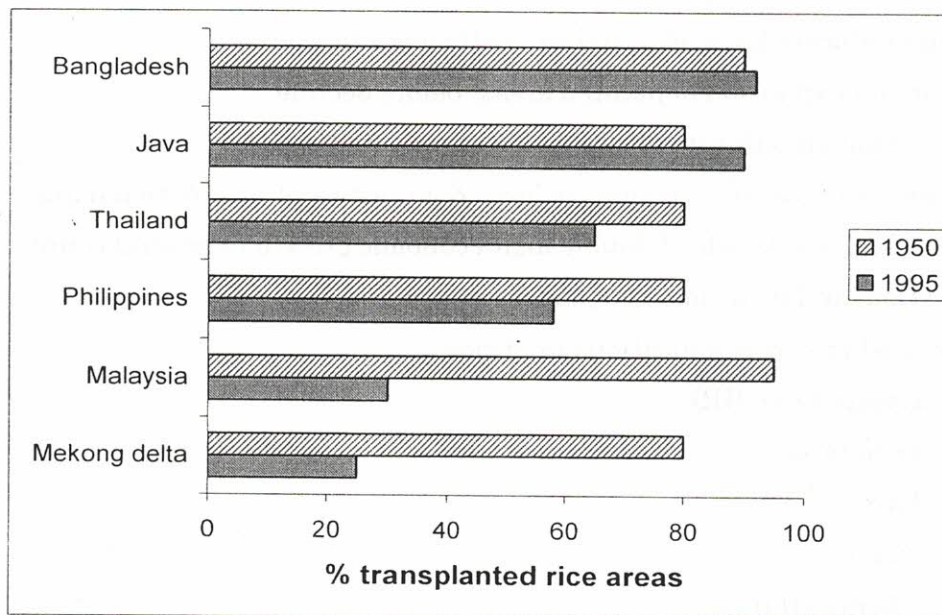
Flexible mechanization benefits a vast majority of rice growers

- Labor days / Ha in irrigated rice fields:

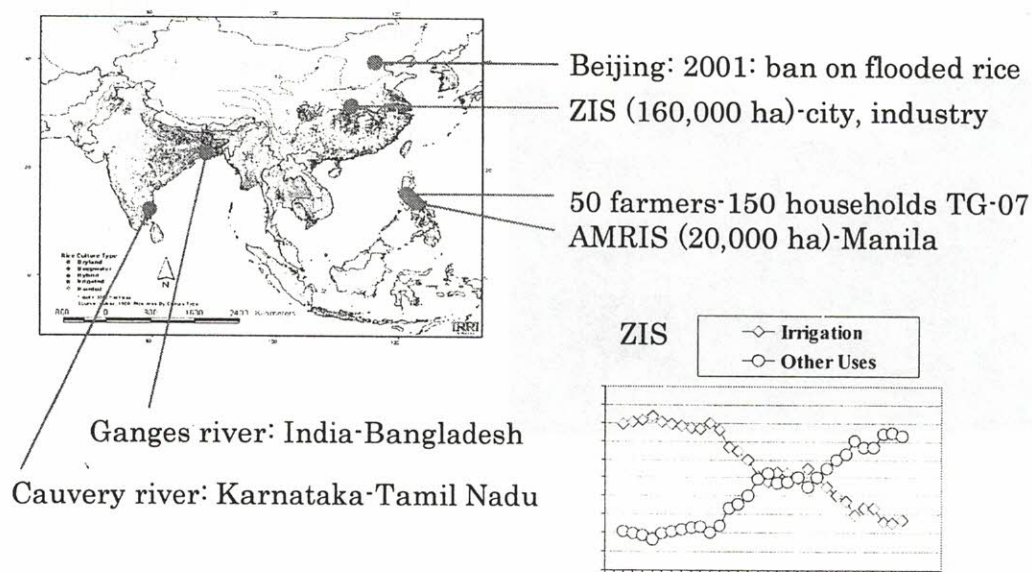


	Taiwan	Japan
➤ 1960:	864	1729
➤ 1970:	844	1178
➤ 1980:	394	644
➤ 1990:	238	438

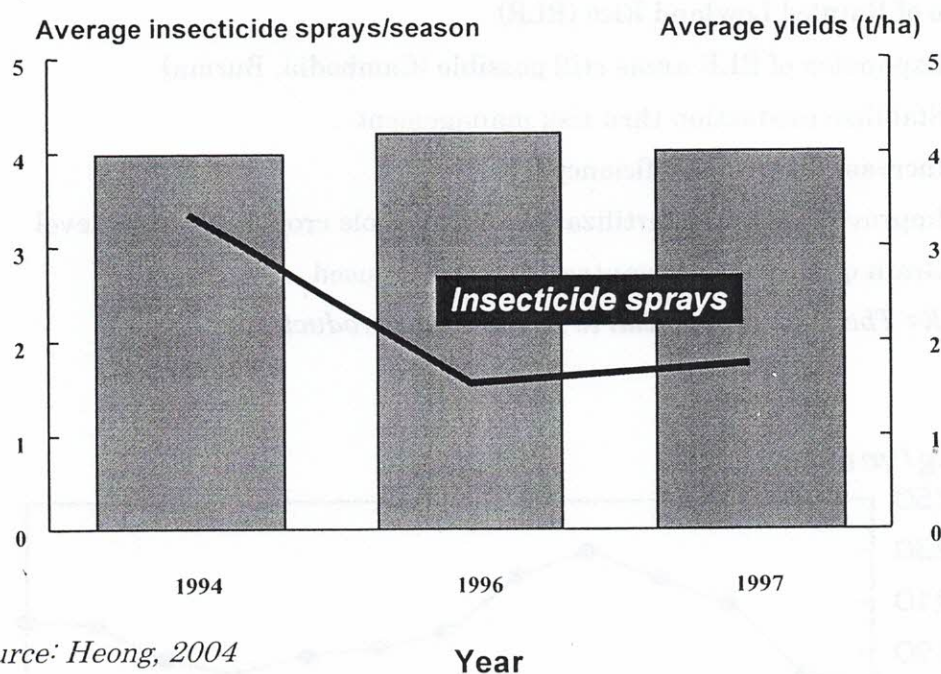
Labour scarcity & shift from transplanted to direct seeded rice



Competition for water: some examples in rice areas



Insecticide use and rice yields Long An province, Vietnam



Source: Heong, 2004

Cost of herbicides & labour depending on crop establishment techniques : wet-seeded or transplanted. (USD/ha).

Country	Herbicide cost			Total labour cost before harvest		
	TPR	Wet-seeded	Difference Seeded-TPR	TPR	Wet-seeded	Difference Seeded-TPR
Philippines	7	9	+2	36	8	-28
Malaysia	6	20	+14	205	114	-91

Source: Pingali, 1998.

Diversity of post-green revolution issues & problematiques (2)

❖ Case of Rainfed Lowland Rice (RLR)

- Expansion of RLR areas still possible (Cambodia, Burma)
- Stabilize production thru risk management
- Increase water use efficiency
- Improve integrated fertilization at the whole cropping system level
- Grain quality: key advantage to be better used

❖ *RLR= The largest potential to increase rice production*

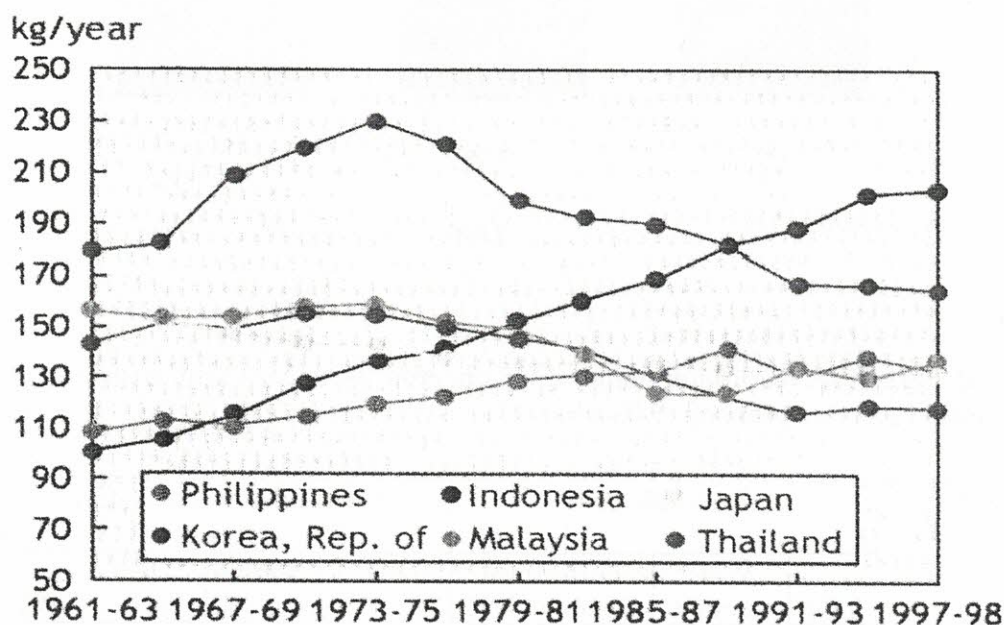


Fig. 1. Trend in per capita cereal consumption, selected Asian countries, 1961-98.

Diversity of post-green revolution issues & problematiques (3)

❖ Case of the upland rice ecosystem (UR)

- Shrinking areas / End of self-sufficiency in SEA
- Included in diversifying systems, better at conserving soil & water
- UR= Still an important role in poor eastern India
- New drought tolerant strains, rice-legumes syst.
- Grain quality: key advantage in some areas

❖ *UR will NOT contribute to the needed increase in global rice production by 2025*

❖ Case of deep water rice ecosystem (DWR)

- Shrinking area / diversification, drainage & irrigation (Bangladesh, Thailand, Vietnam, etc.)
- Tolerance to sudden & deep submersion
- ❖ Case of tidal & coastal rice ecosystem
 - Receding / expansion of aquaculture
 - Tolerance to water salinity
- ❖ *DWR will NOT contribute to the needed increase in Asian rice production*

Implications for rice research (1)

- ❖ Priorities in irrigated rice ecosystems
 - Increase the yield potential & improve grain quality
 - Expansion of hybrid rice in the humid tropics
 - A new plant type for irrigated rice
 - Increased nutritional value: Fe, Zn, pro-vitamin A
 - Improve the sustainable management of resources
 - Increase input use efficiency: N nutrition, pesticides
 - Soil management under high productivity IR monoculture: importance of breaking anaerobic conditions
 - Nitrogen: «the right amount, at the right place & the right time»
 - Pest & disease control: biotechnologies, ecological mechanisms, biodiversity management
 - Water scarcity and aerobic rice: high stakes in China

Progress made in grain quality

Grain quality improvement

- Components

NARES

↑

IRRI

↓

 - milling (total head rice)
 - physical (length, breadth, width, chalkiness)
 - chemical (amylose, gel consistency, gel temp)
 - cooking (water absorption, gel elongation, stickiness, aroma)
 - sensory qualities (aroma, palatability)

- Progress made so far
 - Indica rice *****
 - NPT rice ***
 - Hybrid rice **



Grain Size & Shape	Long & Slender
Amylose	22%
Gelatinization Temperature	Intermediate
Gel Consistency	Soft
Chalkiness	<20%
Milling %	
Total	70%
Head Rice	60%

Implications for rice research (2)

❖ Priorities in Rainfed Lowland Rice areas

- Better use of heterogeneity & variability of the milieu
 - More dynamic systems approaches
 - Increase the level of adaptation to the environment
- Biotechnological break-throughs re. abiotic stresses?
- Mastering the build-up of grain quality in the field and its conservation along the commodity chain (aromas)
- More investment in this fragile ecosystem / higher rates of return on research efforts

❖ New technologies and decision support

- « high science - low tech » innovations
- New dissemination of knowledge & information

Northeast Thailand: zonation for management strategies to cope with drought

Zone A

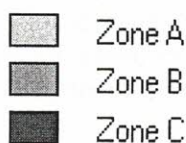
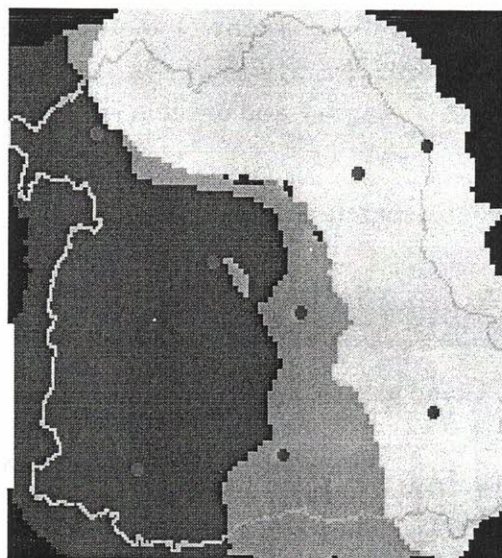
- ❖ Favorable water balance favours transplanting

Zone B

- ❖ Transplanting tends to be delayed

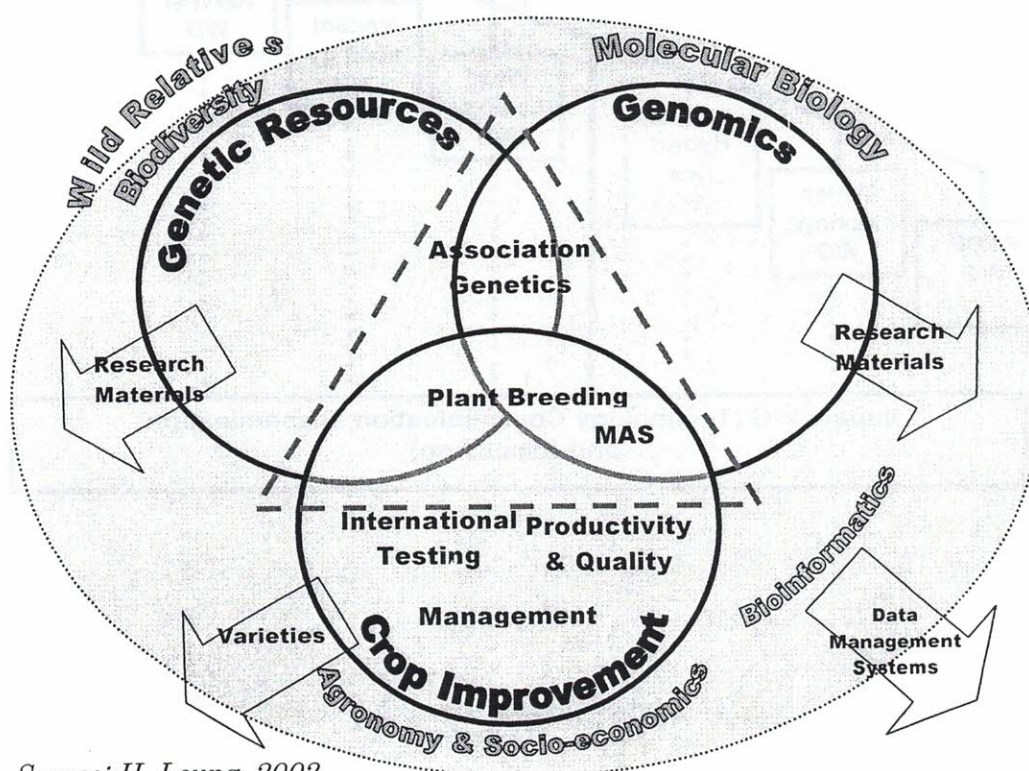
Zone C

- ❖ Direct seeding to offset risk of transplanting failure



Consequences on the organization of rice research (1)

- ❖ International level: from IRRI as a « Centre » to as « facilitator » of the global rice research system global
 - « The role of IRRI consists to evaluate, not to promote » (R. Cantrell, DG, 2000)
 - A more balanced research agenda between IR & RLR
 - A negotiated division of labour with NARES
 - Interdisciplinary research is making too slow progress,
 - The quantification of research impact is more needed...
 - In times of donor fatigue (IRRI funding: -50%)



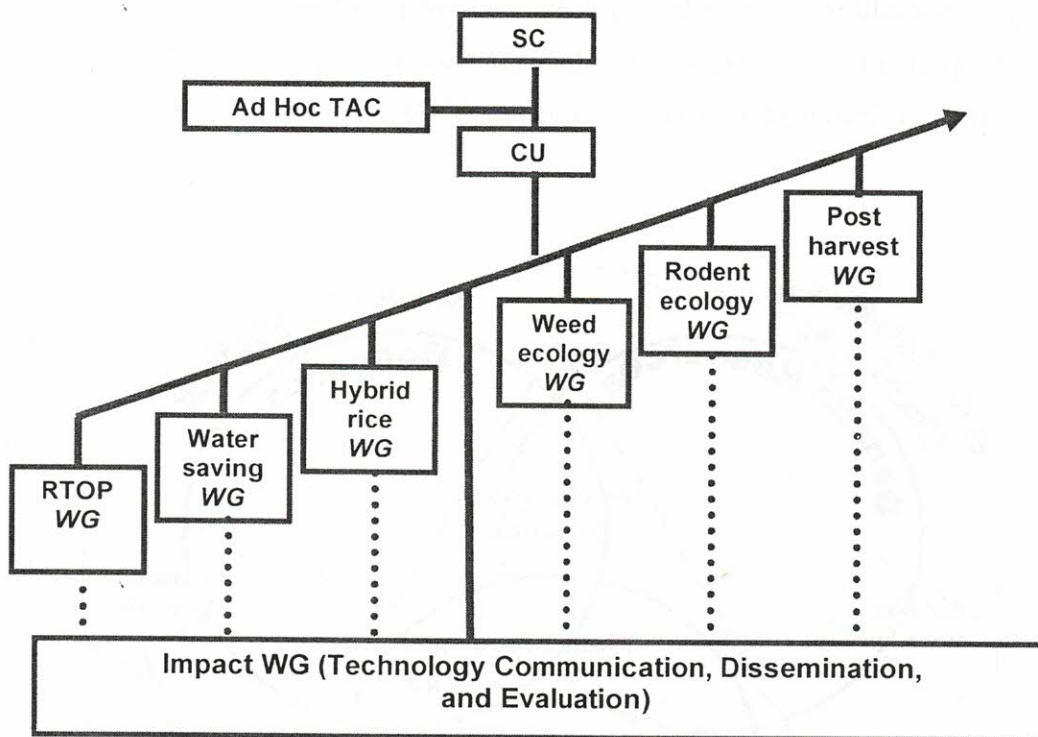
Source: H. Leung, 2002

Consequences on the organization of rice research (2)

- ❖ International division of research work
 - Expansion of themes & research objects: more upstream (functional genomics, bioinformatics, etc.) & downstream (more impact)
 - Strengthening partnerships, diverse collaboration / capacity of various NARES:
 - « joint ventures », « frontier projects »
 - « shuttle programs (exchange of researchers) »

- « consortiums » per rice ecosystem (IRRC, RLR)
- « research networks » per theme, innovative tool, etc.
- « technological evaluation networks » (INGER, CREMNET)
- « national projects » to reinforce research capacity
- « services », training (20-25/year, more & more distributed)

Irrigated Rice Research Consortium



Consequences on the organization of rice research (3)

- ❖ Broadening partnerships along the research-development-impact continuum
 - With the actors of local agricultural development: NGOs, professional organizations, etc.
 - With the private sector (still limited):
 - Hybrid rice (Inde)
 - Agricultural machinery (SMEs)
 - IPR: a very hot topic!
- ❖ Increased contribution from mature NARES
 - In the ecosystem-based consortiums
 - In regional research organizations

Number of countries contributing germplasm to INGER, 1991-2002

❖ 1991 - 12	❖ 1997 - 10
❖ 1992 - 7	❖ 1998 - 7
❖ 1993 - 11	❖ 1999 - 9
❖ 1994 - 13	❖ 2000 - 6
❖ 1995 - 17	❖ 2001 - 3
❖ 1996 - 13	❖ 2002 - 2

Source: Javier, 2002

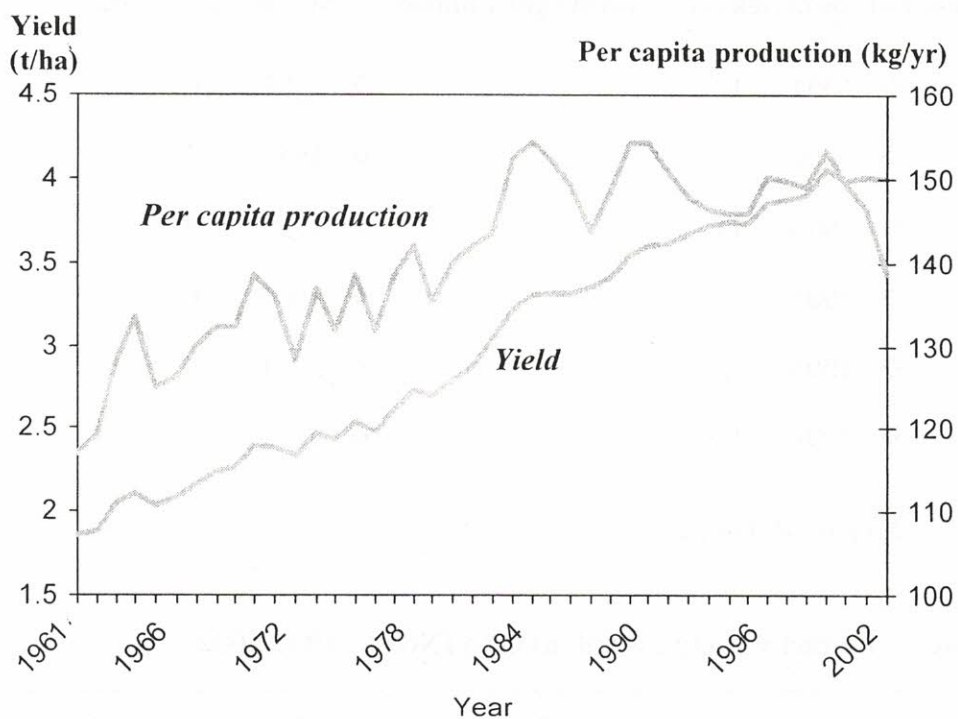
Number of direct variety contribution to INGER, 1985-2002

Country	85-93	94-97	98-02
India	1016	205	0
Bangladesh	255	55	0
Indonesia	179	0	0
Thailand	150	183	8
Vietnam	22	44	26
China	159	76	30

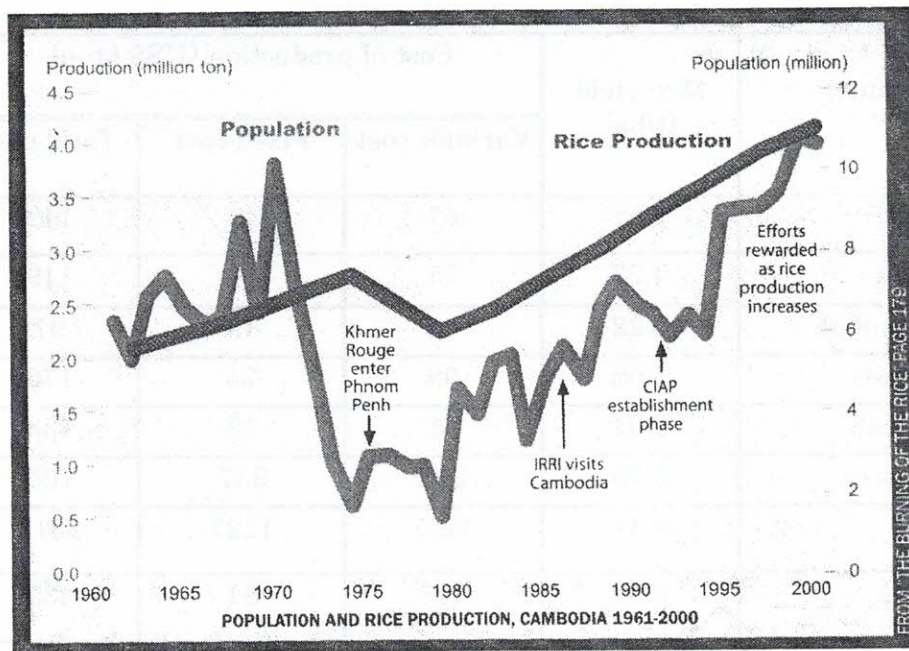
Rice stake in Asia in the early 21st century (1)

- ❖ Increase production / population growth in spite of eroded productivity gains
 - 1967-1985: 2.3%/year, 1985-1995: 1.4%/year
 - Exceptions: India, Vietnam
- ❖ Gains more & more difficult to access / danger more degradation of resource base
- ❖ Increased incomes and rice demand
 - 1990-2025: Philippines=+ 65%, Vietnam= + 75%,
 - India & Indonesia= + 70%, Bangladesh= + 80%!

Growth in rice yield and per capita rice production Asia, 1961-2002



Production Asia, 1961-2002



Rice stake in Asia in the early 21st century (2)

❖ Increased incomes and rice demand

- Annual income / capita > 1500 \$US: decrease in rice consumption / capita
- Asian urbanization: 1/3 in 1990, 1/2 in 2020
- WTO: towards mutations in trade rules in the Far East? More tensions on markets?
- Risk of cereal deficit in South Asia
- Increase in rice demand: 1.7 % / an (2% in South Asia, 2.5% in India, compared to 1.2 % in China)
- Need supplementary production of 6.7 million tons every year

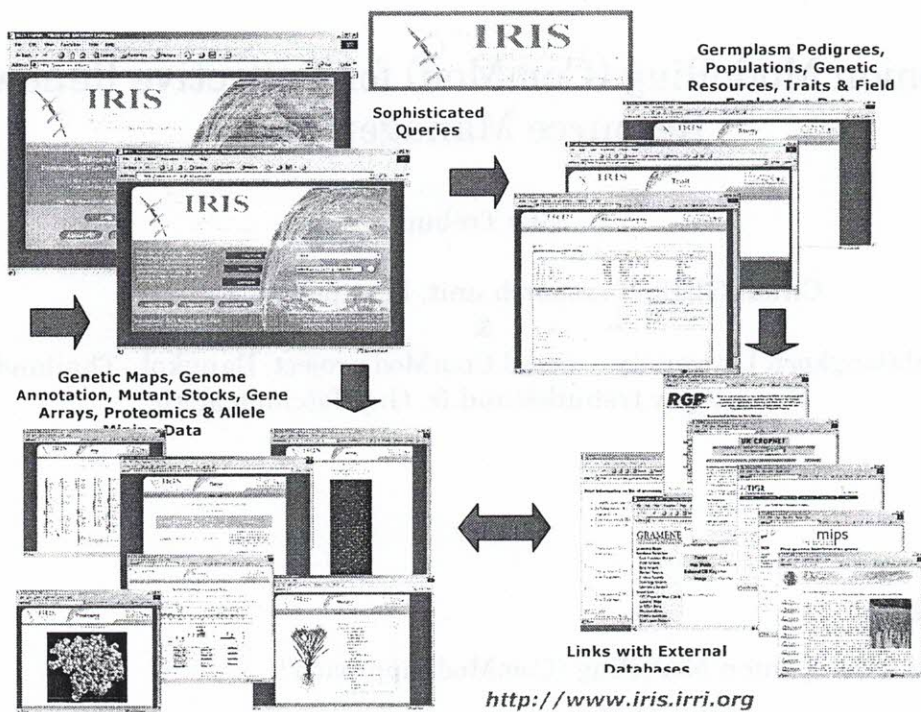
Comparison of rice yield and unit cost of production, selected countries

Country	Rice yield (t/ha)	Cost of production (US\$ / ton)		
		Variable cost	Fixed cost	Total cost
Thailand	2.57	67	45	112
Vietnam	4.27	75	44	119
Indian Punjab	5.28	48	49	97
Philippines	3.08	99	71	170
Bangladesh	3.64	61	72	133
South Korea	6.75	368	337	705
Japan	6.41	1185	1127	2312
USA	6.53	148	84	233

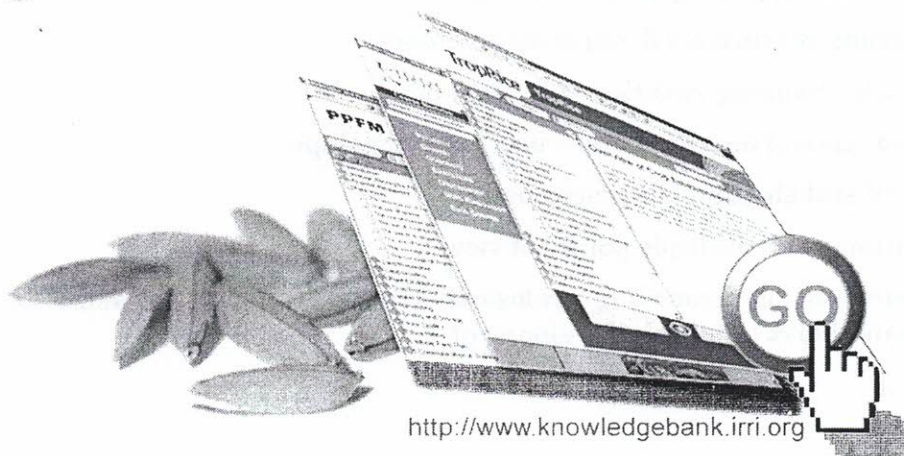
Source : Hossain, 2002

Conclusion : Conditions for success

- ❖ Need for new investments & economic incentives
 - Support the commercial diversification of small-scale rice production systems to increase incomes
- ❖ Need for more diverse technological innovations, more environment friendly
- ❖ Adopt the adaptive management paradigm
- ❖ Decentralize the management of local renewable resources & new communication systems for the diffusion of knowledge & information
- ❖ Stop the current decreasing investment in public research



Rice Knowledge Bank The world's rice knowledge repository. 水稻知识网



Companion Modelling (ComMod) for Collective Renewable Resource Management

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&

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E-mail: guy.trebuil@cirad.fr, Guy.T@chula.ac.th

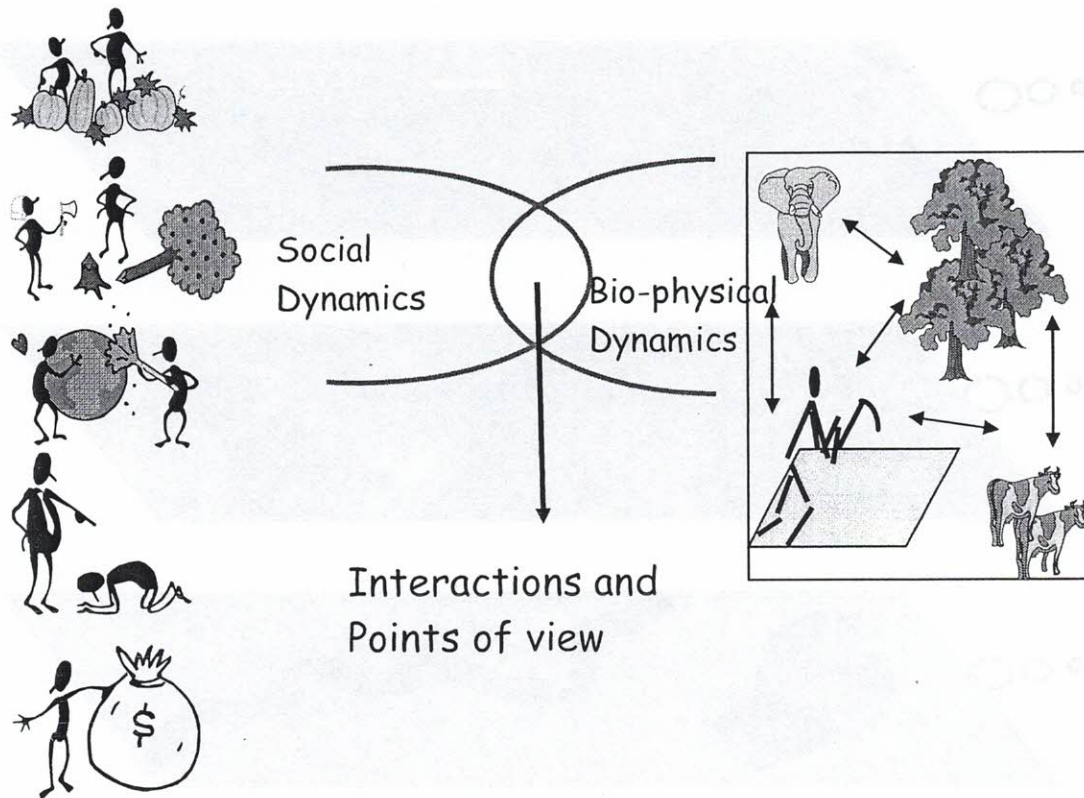
Contents

- ❖ Why a Companion Modelling (ComMod) approach?
- ❖ Characteristics of ComMod
- ❖ An example: Watershed management in upper Northern Thailand: Land degradation risk & market integration / agri. Commercialization
- ❖ ComMod concepts and methodological principles
- ❖ Scientific challenges & perspectives

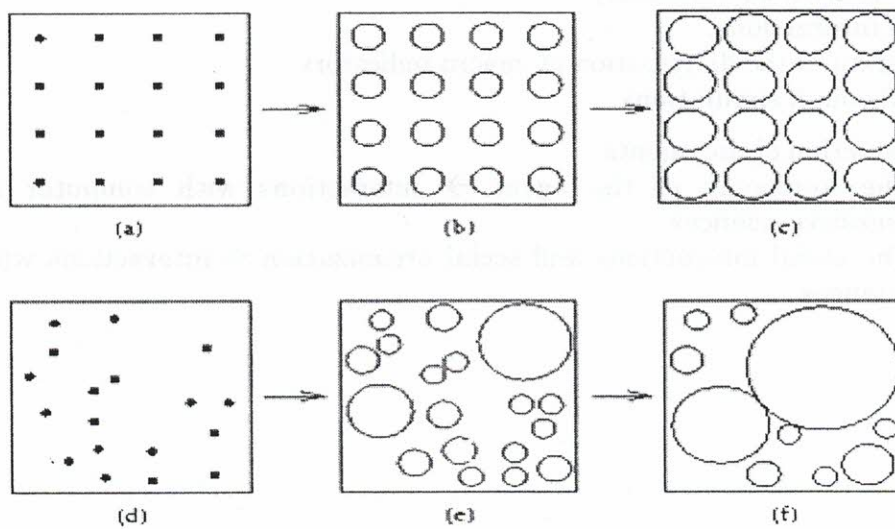
Characteristics of today RRM problems

- Increased complexity & uncertainty
- Evolving, continuous & iterative processes
- Rapidly changing realities → System openness
- Importance of environment – users relationships
- And of stakeholders' interactions
- Legitimacy of multiple points of view
- Importance of reconciling ecological & socio-economic dynamics to promote sustainable & equitable development

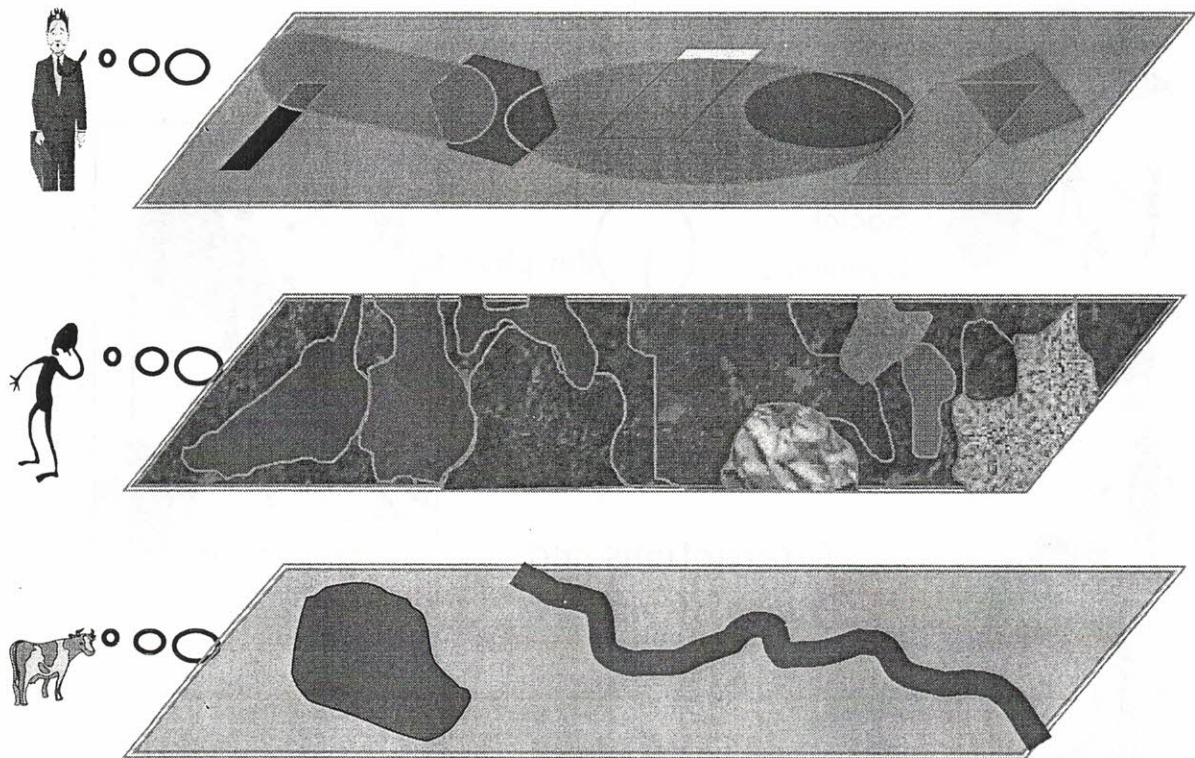
Common agroecosystem



Importance of individual uniqueness & local interactions



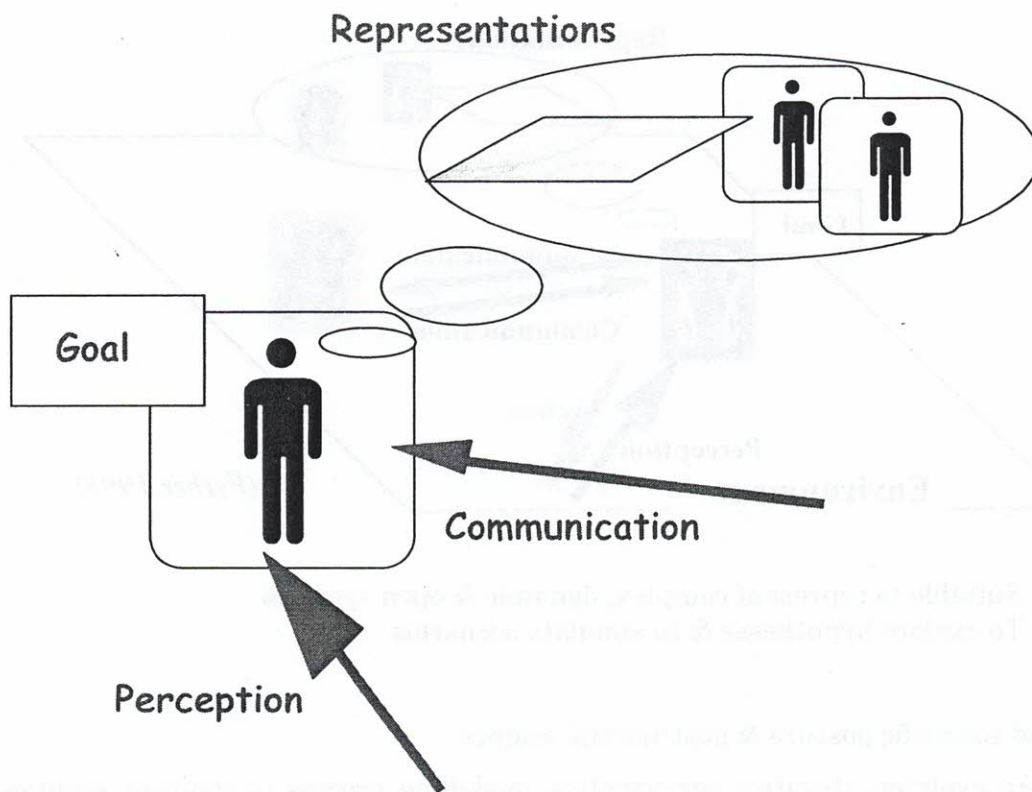
Different agents' representations of their common environment



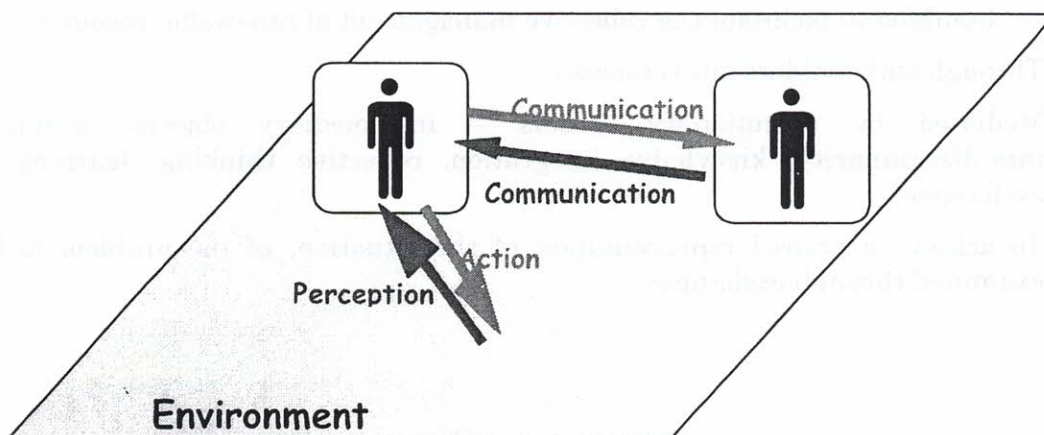
Tools for harnessing complexity

- Bottom-up approaches
- Individual-based modelling (IBM, microsimulations)
 - Inter-individual variability
 - Local interactions
 - Understand the distribution of macro indicators
 - Use through simulations
- Introduction of the agents
 - The autonomy of the agent → interactions with computer sciences, cognitive sciences
 - The social interactions and social organization → interactions with social sciences

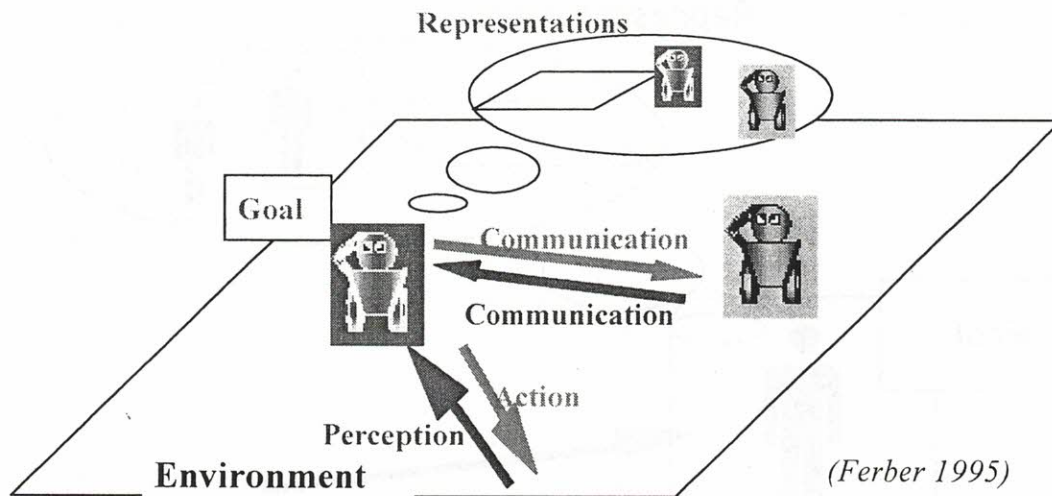
Focus on individual decision-making processes



Interactions among agents and their common environment



Multi-Agent Systems (MAS)

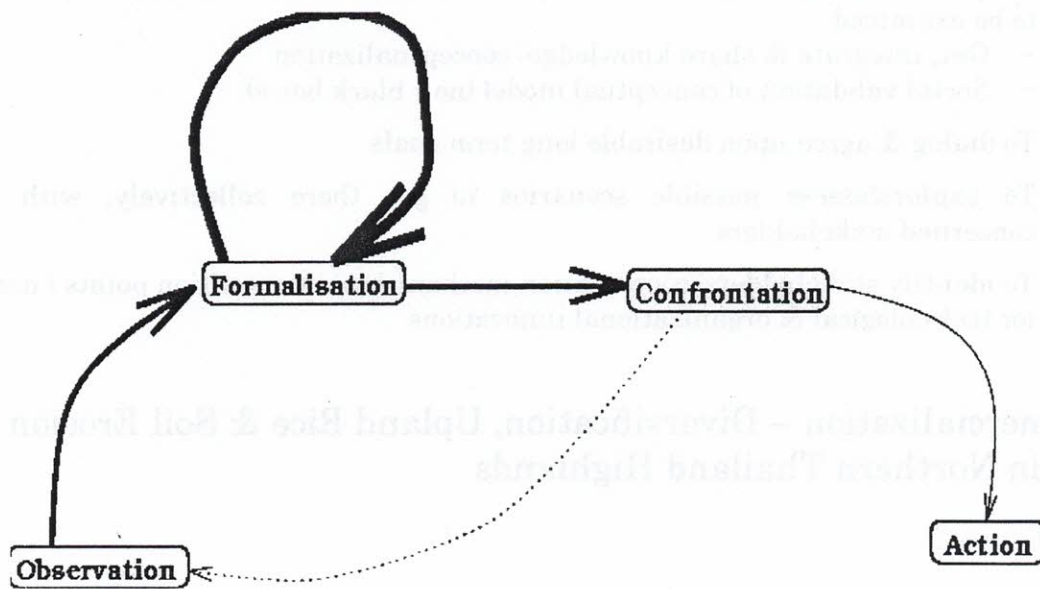


- Suitable to represent complex, dynamic & open systems
- To explore hypotheses & to simulate scenarios

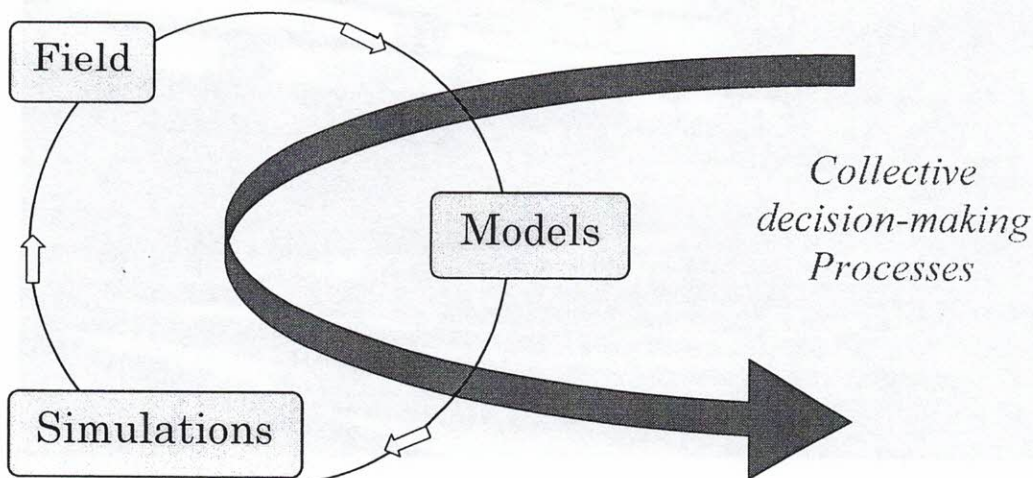
ComMod scientific posture & post-normal science

- An evolving, iterative participatory modelling process to confront realities & theories: Field -> Model -> Field -> Simulation -> Field, etc.
- Permanent confrontation with dynamic realities: System openness, uncertainties taken into account & multiple legitimate points of views
- Two specific contexts:
 - ComMod to understand a complex system &
 - ComMod to facilitate the collective management of renewable resources
- Through stakeholders interactions...
- Mediated by evolutionary models = intermediary objects, facilitate interdisciplinarity, knowledge integration, collective thinking, learning & exchanges
- To achieve a shared representation of the situation, of the problem to be examined through exchanges

MAS-based companion modelling approach and the real world



The companion modelling approach



Objective of the Companion Modelling approach

- To facilitate dialogue, shared learning & collective decision-making
- To strengthen the adaptive management capacity of local communities through interdisciplinary and action-oriented research

ComMod objectives & main phases of the process

- To build a common representation of the complex system & concrete problem to be examined
 - Get, integrate & share knowledge: conceptualization
 - Social validation of conceptual model (no « black box »)
- To dialog & agree upon desirable long term goals
- To explore/assess possible scenarios to get there collectively, with all concerned stakeholders
- To identify stakeholders' coordination mechanisms, intervention points / needs for technological & organizational innovations

Commercialization – Diversification, Upland Rice & Soil Erosion Risk in Northern Thailand Highlands



IRRI-Cirad-DOA Project & Multiple Cropping Center, Faculty of Agriculture, Chiang Mai University, Thailand

Ecological Resilience: Revised definition

- Recent research emphasizes the possibility for a system to adapt to change as a major component of ecological resilience, in addition to recovery or reorganization following disturbances
- The revised definition (Carpenter et al. 2001) defines resilience applied to integrated systems of people & nature, as:
 - the amount of disturbance a system can absorb and still remain within the same state of domain of attraction
 - the degree to which the system is capable of **self-organization** (versus lack of organization, or organization forced by external factors) and
 - the degree to which the system can build and increase its **capacity for learning and adaptation**

Adaptive management

- An open management process which seeks to include past, present, and future stakeholders
- Need to at least maintain political openness, but usually it needs to create it. Consequently, adaptive management must be a social as well as scientific process. It must focus on the development of new institutions / rules and institutional strategies just as much as upon scientific hypotheses and experimental frameworks
- Adaptive management attempts to use a scientific approach, accompanied by collegial hypotheses testing to build understanding, collective learning, to enhance institutional flexibility and encourage the formation of the new institutions that are required to use this understanding on a day-to-day basis

Integrated Natural Resource Management (INRM) CGIAR task force - Penang Meeting (2000)

Adaptive management : building and maintaining stocks of biodiversity that ensure functional integrity of the system can increase the adaptive capacity. Adaptive capacity is dependent on knowledge –its generation and free interchange- the ability to recognize points of intervention and to construct a bank of options for resource management.

Modelling proceeds iteratively by successive approximations usually from simple to more complex representations of system dynamics. This iterative modelling is done in close interaction with stakeholders who along with the modellers use the models for scenario planning.

Adaptive capacity

- In ecological systems: genetic diversity, biological diversity, and the heterogeneity of landscape mosaics
- In social systems: the existence of institutions and networks that learn and store knowledge and experience, create flexibility in problem solving and balance power among interest groups

- Systems with high adaptive capacity are able to re-configure themselves without significant declines in crucial functions in relation to primary productivity, hydrological cycles, social relations, and economic prosperity
- A consequence of a loss of resilience, and therefore of adaptive capacity, is loss of opportunity, constrained options during periods of re-organization and renewal, an inability of the system to do different things

Resilience & adaptive capacity

- Are there elements that sustain adaptive capacity of social-ecological systems in a world that is constantly changing?
- Folke et al. (2002) identify four critical factors that interact across temporal and spatial scales and that seem to be required for dealing with natural resource dynamics during periods of change and reorganization:
 - learning to live with change and uncertainty
 - nurturing diversity for resilience
 - combining different types of knowledge for learning; and
 - creating opportunity for self-organization towards social-ecological sustainability

Some conclusions on these key concepts

- A theoretical framework for looking at the resilience of ecosystems & adaptive management / capacity
- Importance of institutions & collective / continuous learning
- Use of models mainly to explore scenarios of possible futures

Managing complex agro-ecosystems: a general ComMod methodology

- Understand & describe a system and its dynamics
- Represent it / Model it to allow simulations of possible futures & the assessment of scenarios
- Support all concerned stakeholders in learning and deciding about the system changes

Two main types of situations for ComMod users

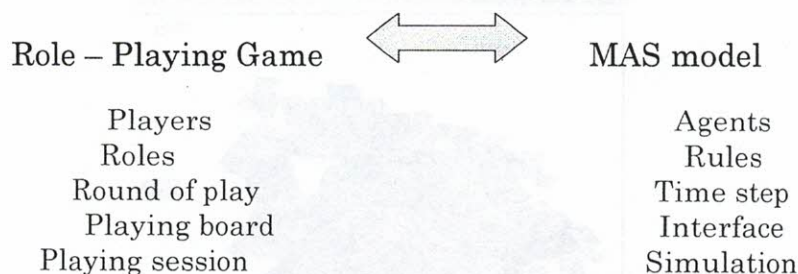
- 1st situation: Understanding a complex system
 - Systems research with specific tools & relation to the field
 - Structure of exchanges: Preliminary researcher model -> Validation with actors -> New model, more adapted to actors' concerns -> Validation -> Simulations of stakeholders' scenarios -> New questions, etc.
 - Production of new knowledge on the problem & relevant processes dominates
 - Mutual recognition of knowledge & representations
 - A learning process through interactions among actors

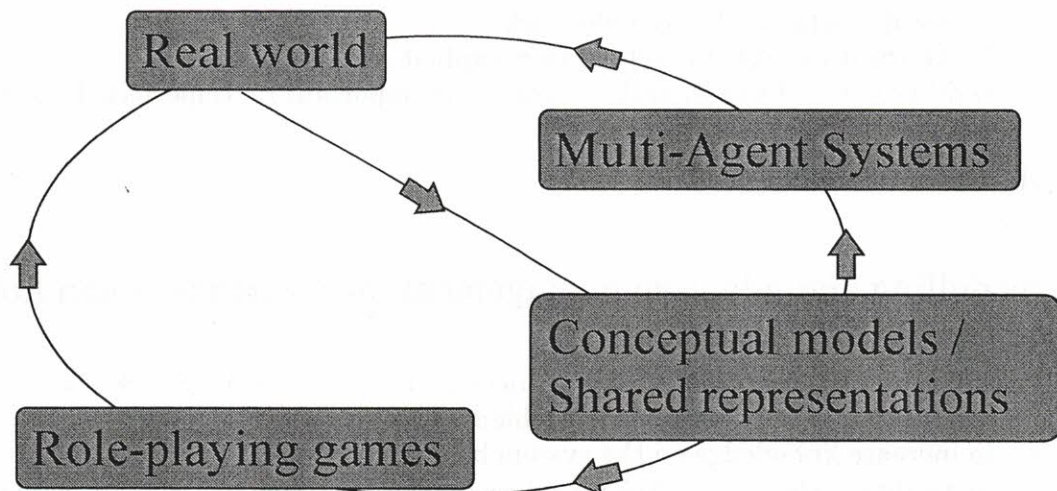
- 2nd situation: To support & improve collective decision-making regarding a key NRM problem
 - Methodological research to facilitate/accompany concerted (evolving, iterative, continuous) processes
 - Particular relationship to field work
 - Make the diversity of points of view explicit
 - Quality of the decision-making process is important / « Imperfect decisions » in uncertain environments
- *A joint use is advocated*

MAS modelling and adaptive management: synergies between Role Playing Games & MAS models

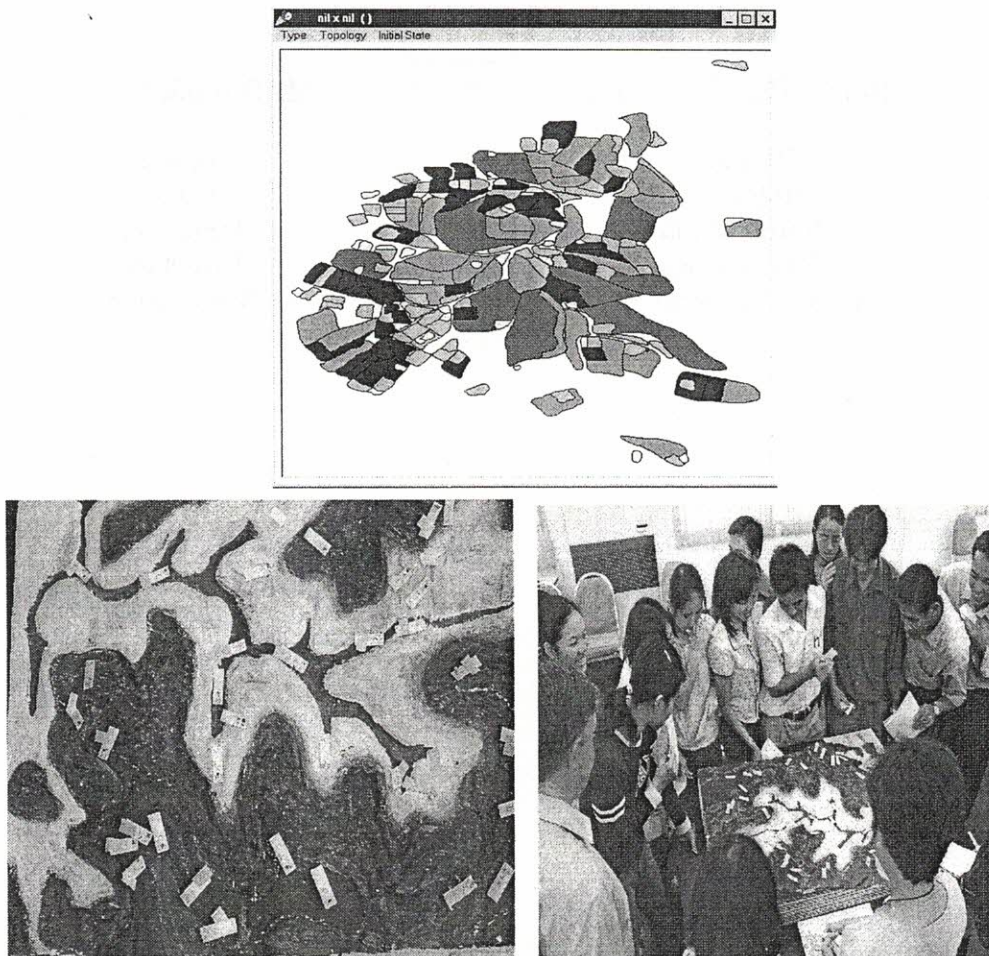
- Role-playing games (RPG) and multi-agent systems (MAS) → Common representation of the system / the problem to be examined
 - to increase knowledge on the system behaviour
 - to facilitate the use of MAS models by the stakeholders and to validate them
 - to be able to simulate and to assess scenarios of changes with stakeholders

Complementarity & similarities between Role – Playing Games (RPG) and MAS models

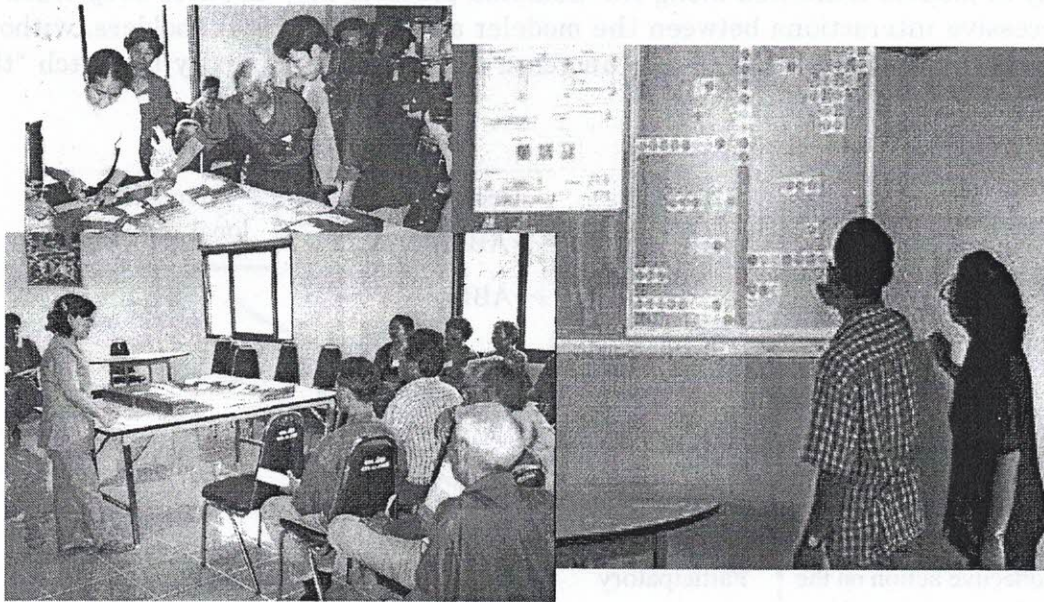




Role-playing game based on a simplified version of the MAS model: north Thailand highlands



A MAS model built from an earlier Role-Playing Game to simulate and assess scenarios with stakeholders



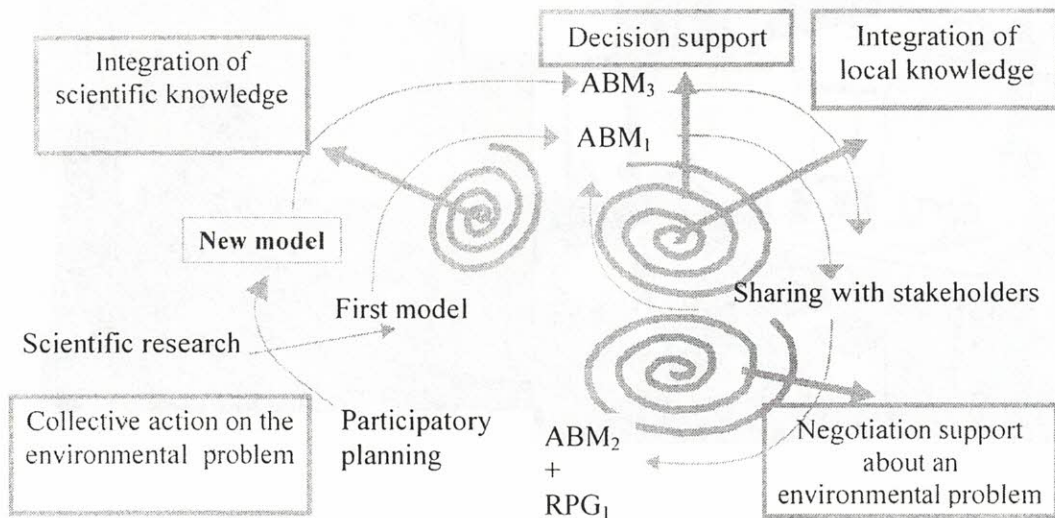
ComMod & Knowledge Production (1)

Research on real world complex systems *via* a particular relationship to field activities

1. Theoretical and methodological investigations to be judged by peers, but always based on real world questions from the field
2. Problems to be investigated are chosen both for their:
 - methodological interest and
 - relevance to users & decision makers with whom we work
3. No implicit hypothesis stated before the experiment: this is an objective in itself and implies the adoption of procedures to reveal such implicit hypotheses at both empirical & conceptual levels
4. All assumptions made during modelling are intended to be discarded after each interaction with the field, i.e., each assumption must be voluntarily & directly subjected to refutation
5. Each new cycle of the ComMod process takes into account any new internal or external component
6. All the contrasted & potentially contradictory points of view are considered as legitimate & need to be taken into account

ComMod & Knowledge Production (2)

A family of models is created along the ComMod process, they allow to keep track of the successive interactions between the modeler and the field/ stakeholders, without any *a priori* willingness to gradually increase the models complexity to match “the reality”.



ComMod to support collective decision making processes

- ComMod comes into play upstream of any technical decision made by stakeholders to solve a problem. It is used to stimulate, organize and guide the exchanges among the various stakeholders, with the main objectives of producing a shared representation of the problem & identifying ways of dealing with it which are acceptable to all parties
- When facing a complex problem, the decision-making process is evolutionary, iterative, continuous and that it always produces imperfect (non-optimal) “decisions”, but following each iteration they are less and less imperfect and more widely shared
- The question is not the (technical) quality of the choice, but the quality of the collective process leading to it. It is not about finding “the best” solution, but about examining the uncertainties of the situation & the acceptability of “solutions” with as much clarity as possible
- Importance of paying attention to / identifying the various viewpoints and subjective criteria to which the different stakeholders refer implicitly or even unconsciously
- Stakeholders learn collectively by creating, observing & modifying simulations: simulation provides them with a non-confrontational way to influence the collective decision-making process by creating & modifying representations of situations
- ComMod provides an effective framework to stimulate dialogue and information sharing among stakeholders (including experts), a collective learning experience through the exchange of viewpoints, knowledge & beliefs

Set of activities in a ComMod process to be executed in an iterative way

- Step 1: Framing
- Step 2: Prioritization and visioning
- Step 3: Participatory field work and modelling
- Step 4: Collective exploration & discussion of trade-offs displayed by the simulated scenarios
- Step 5: Collective agreement/choice of an action plan
- Step 6: Assessment of local effects and impact

Set of activities in a ComMod process

Step 1: Framing

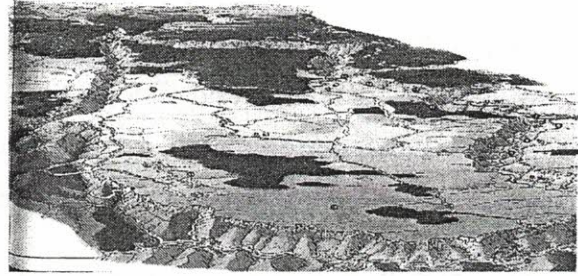
- Preliminary diagnostic analysis at the system level
- Identification & understanding of key ecological & social dynamics, of key problems, concerns & intervention points with stakeholders
- Gathering & synthesis of relevant secondary information & data
- Identification of knowledge gaps to be filled through specific surveys

Step 2: Prioritization & visioning

- Participatory selection of a key concrete problem to be examined by using ComMod
- Establishment of a common vision shared by all key stakeholders through participatory workshops
- Delimitation of areas of agreement or disagreement, uncertainty, and room for coordination & negotiation
- Production of guidelines for monitoring and evaluation of subsequent ComMod activities

Several topics of ComMod experiments

- Management of irrigation schemes in Senegal, West Africa
- Land allocation between grazing and rice growing areas in Senegal
- Negotiation between sheperds and foresters in Mediterranean forests
- Watershed management for soil & water conservation with Akhas farmers in upper northern Thailand
- Allocation of irrigation water between villages in Lingmuteychu, Bhutan
- Management of pine encroachment on grazing and park land by Causse Méjan foresters, shepherds and conservationists in Southern France
- Environmental mediation about phytogenetics management in Madagascar
- Other themes: biodiversity management, supply chain management, Etc.



Step 3: Participatory field work & modelling

- Implementation of a user friendly, iterative & flexible modelling approach combining field workshops & laboratory work
- Joint validation of the simulated tool with all concerned stakeholders
- Collective identification of relevant resource management scenarios to be simulated and assessed by the participants (taking into account the competing uses of resources by multiple users)

Step 4: Collective exploration and discussion of trade-offs displayed by simulated scenarios

- Identification of win-win situations / who gains / who is losing
- Identification / negotiation of new resource management rules →

Step 5: choice and design of an agreed upon action plan to tackle the resource management problem

Developing the ComMod approach by:

- Taking advantages of the numerous past or on-going applications in diverse contexts : ex-post analyses to be conducted
- Defining a common framework for the in-depth analysis of the results from each experiment
- Analyzing each experiment according to this common framework
- Proposing a ComMod methodology that:
 - remains adaptive
 - but underlines several generic characteristics of this approach
- Refining the contents of the ComMod charter as needed

Improving the visibility, legibility & legitimacy of the ComMod Approach

- Analysis of similarities & differences or complementarities compared to other participatory modelling approaches
- Identification of ComMod strengths, weaknesses & constraints
- Characterization of the contexts in which ComMod can be used & how it should be used.

Scientific challenges ahead

- Impact assessment: how to measure improvement in stakeholders' capacity for collective learning?
- What indicators of system resilience & and to identify them with stakeholders?
- Upscaling ComMod: from heterogeneous agents / individuals to groups / organizations
- Modelling stakeholder perceptions & their spatial representations.

Support for collective decision-making processes

- Companion modelling comes into play upstream of the technical decision. It guides the discussions of the various stakeholders involved, with a view to producing a shared representation of the problem, and identifying effective ways of dealing with it.
- When facing a complex situation, the decision-making process is evolutive, iterative, and continuous. This means that the process always produces imperfect "decisions", but following each iteration they are less imperfect and more widely shared
- The question is not the quality of the choice, but the quality of the process leading up to it. It is not about finding the best solution, but about examining the uncertainties of the situation with as much clarity as possible
- Identifying the various viewpoints and subjective criteria to which the different stakeholders refer implicitly or even unconsciously
- Stakeholders learn collectively by creating, modifying, and observing simulations because simulation provides a mean to act on the decision-making process by creating or modifying representations
- More effective dialogue among stakeholders (including experts) through a framework for discussion and information sharing, an exchange of viewpoints, knowledge, and beliefs

Perspectives: scientific challenges ahead

- Impact assessment / Collective learning capacity
- Pertinent indicators of system resilience
- Improved modeling of stakeholder perceptions & spatial representations
- Upscaling: from heterogeneous agents / individuals to groups & organizations

For more information

- *On ComMod & Multi-Agent Systems for renewable resource management with stakeholders:*
<http://www.commod.org>
<http://cormas.cirad.fr>

- *On current project activities / training in Asia:*
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CU-Cirad ComMod Project
Faculty of Science, Chulalongkorn University, Bangkok

Companion Modelling to Support Adaptive Land Management in an Akha village of Northern Thailand

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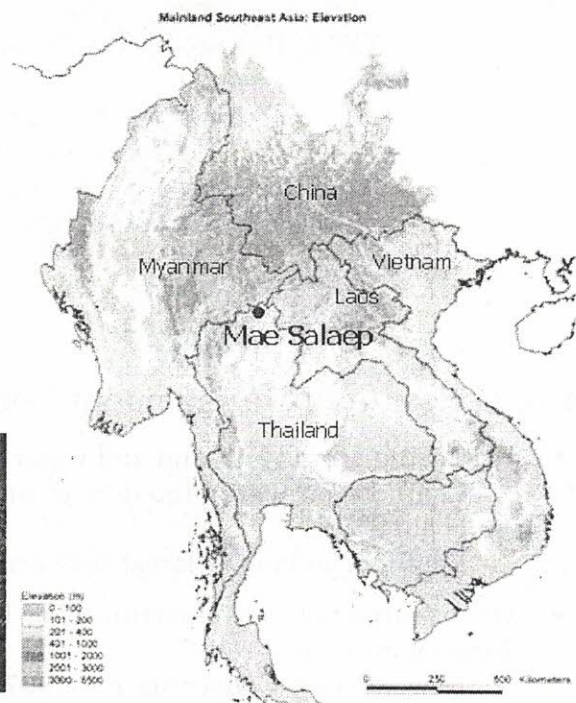
Natural Resource Management Context in Northern Thailand

- Increasing scarcity of land and water resources
 - Conflicts on water (quality & quantity) between upstream/ downstream population
 - Conflicts on land & forest between local communities and the state
- Decentralization: an opportunity for highlanders to increase their say in NRM decision making
 - New « People Constitution » (1997)
 - Elected sub-district (Tambon) councils
- NRM problems and situations are complex & dynamic
 - Numerous interacting agro-ecological & socio-economic aspects
 - Diversity of stakeholders and points of view
 - Uncertain & rapidly changing situations
- Main question: how to enable local stakeholders to manage these complex situations?
 - To define themselves their problems
 - To identify agreed-upon and adapted solutions



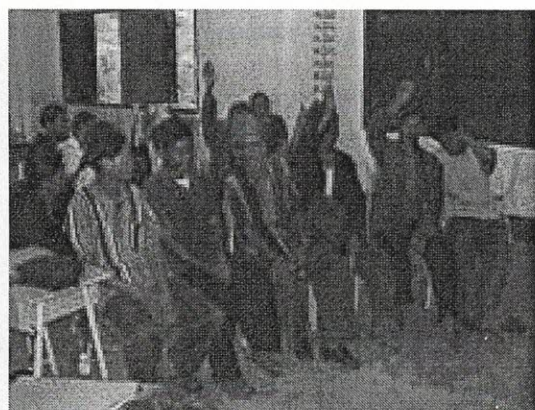
The study site Mae Salaep and the problem of soil erosion

- Land-use dynamics
 - Until 1980s : shifting cultivation mainly for subsistence
 - 1980s-2000s : semi-permanent cultivation, mainly cash crops
- The problem of the increased risk of soil erosion perceived by the lowlanders
- The need to elucidate relation erosion/ crop diversification

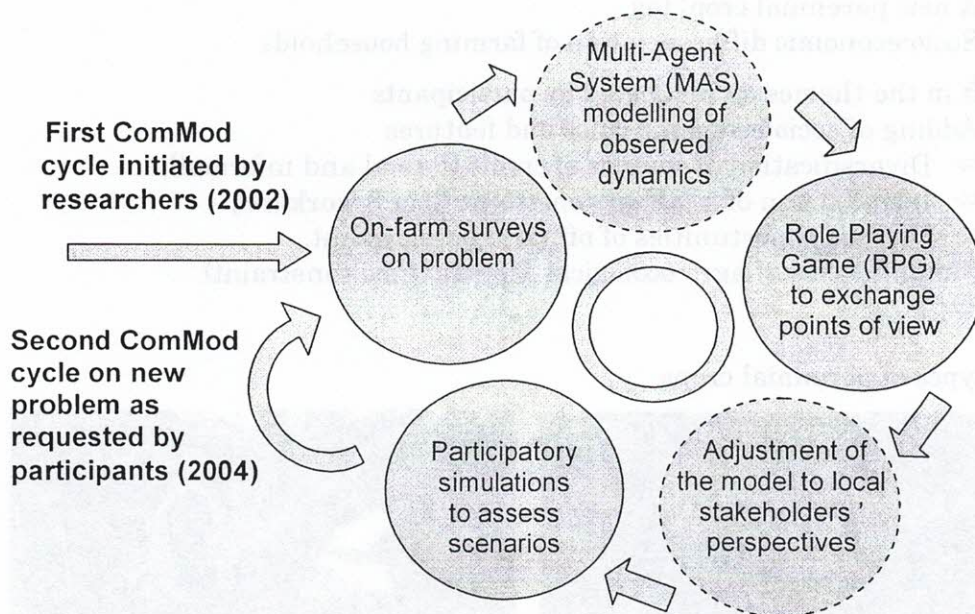


Research objectives

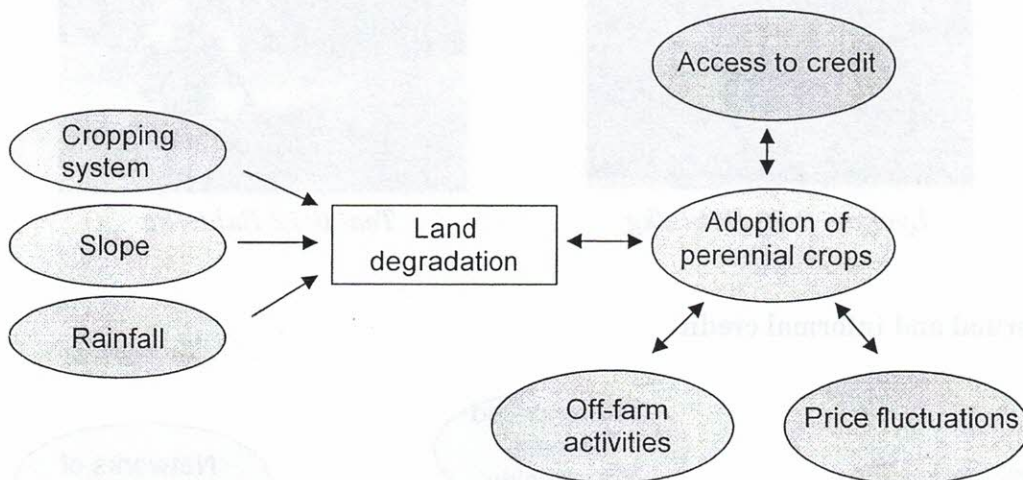
- To generate a collective learning process on the complex problem of land degradation
- To stimulate dialogue among concerned stakeholders (different farming households, local institutions, researchers)
- To facilitate the emergence of agreed-upon and adapted solutions



A second Companion Modelling (ComMod) to adjust to local stakeholders' request



From the first to the second ComMod cycle

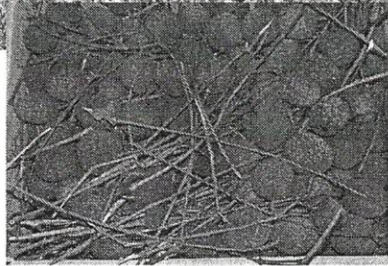


- *Farmers request a shift of focus from agro-ecological to socio-economic concerns*

A new conceptual model (MAS and RPG)

- Updating needed to adjust to local evolutions
 - A new perennial crop: tea
 - Socio-economic differentiation of farming households
- Shift in the themes as requested by participants
 - Adding of socio-economic rules and features
 - ⇒ Diversification of sources of credit (formal and informal),
 - ⇒ Introduction of a labour constraint (2 or 3 workers),
 - ⇒ Diverse opportunities of off-farm employment,
 - Simplification of agro-ecological aspects (time constraint)

Two types of perennial crops

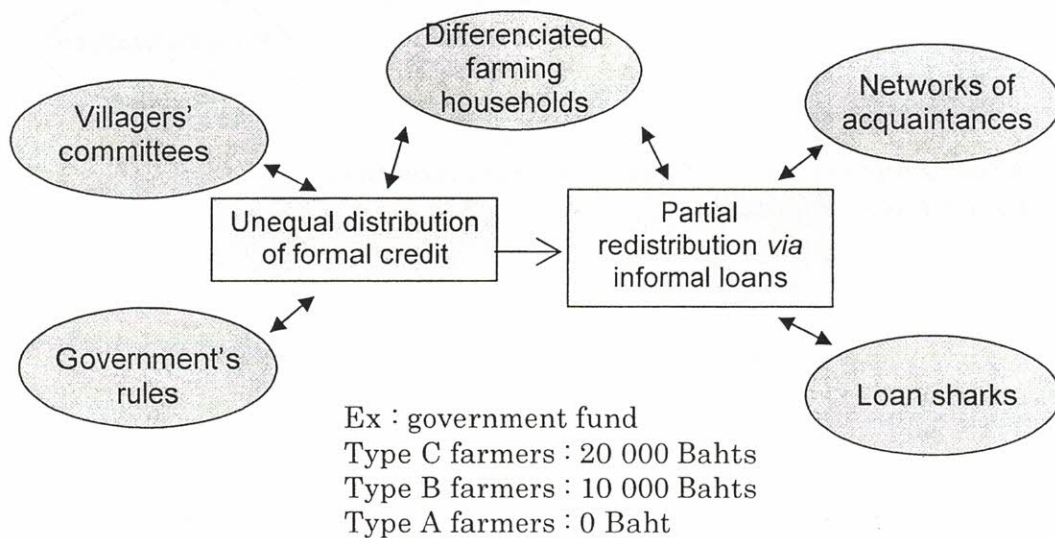


Lychee: 3-70 Bahts/kg

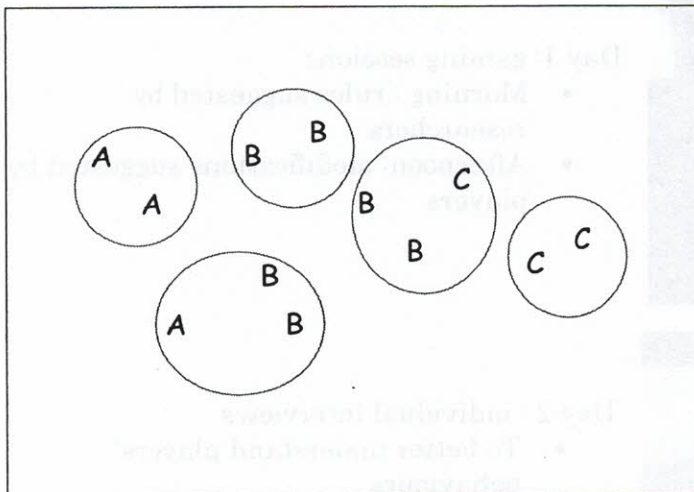


Tea: 6-12 Bahts/kg

Formal and informal credit



Formal and informal credit



Networks of acquaintances

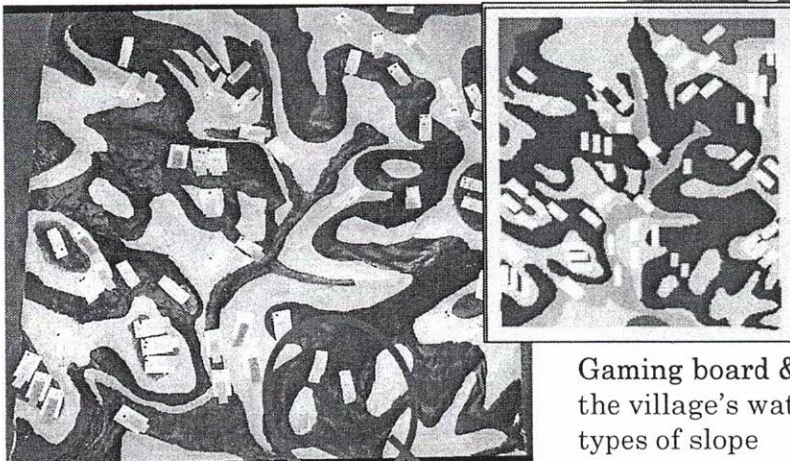
Type A: Small market integrated farms

Type B: Medium-sized & conservative farms

Type C: Large farms & diverse productions

Role Playing Game & Simulations

- Objective: to stimulate exchanges of points of view
 - Between researchers and local stakeholders
 - Among local stakeholders themselves
- Conception: the RPG is a simplified version of the UML & MAS model



Gaming board & MAS interface:
the village's watershed with 4
types of slope

Set of fields belonging to a player



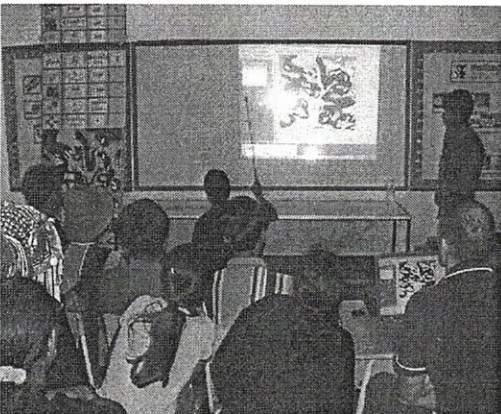
Day 1: gaming sessions

- Morning : rules suggested by researchers
- Afternoon: modifications suggested by players



Day 2 : individual interviews

- To better understand players' behaviours
- To assess the model



Day 3 : collective session of simulations

- To explore scenarios suggested by the players

Main steps of the game/ model



At the gaming board
Choice of crops
Allocation to fields



At the market desk
Draw off-farm cards
Clear accounts

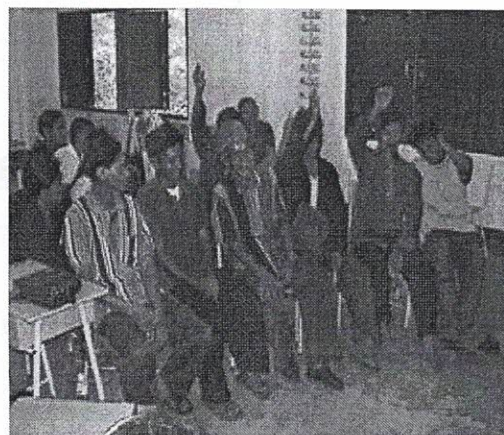
At any time:
free
negotiations
among players

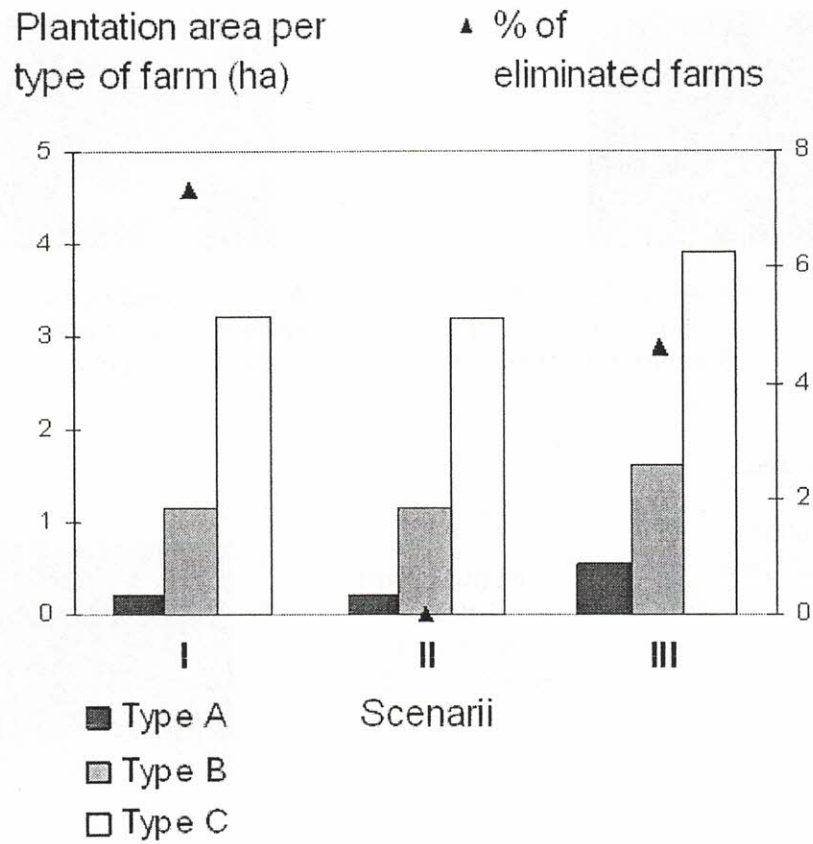
**At the credit
desk**
Request loans
Reimburse loans



Results: what happened in the game?

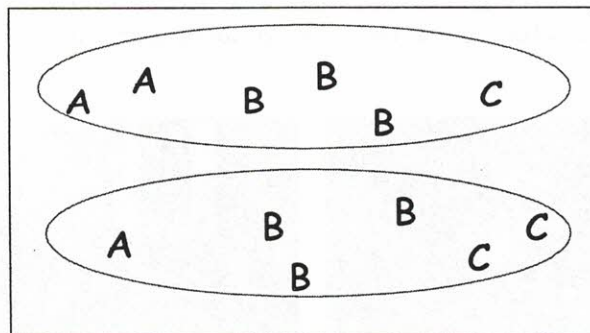
- A first gaming session highlighting the problem of unequal access to perennial crops
- Discussions among players about causes and possible solutions
- Suggestion of scenarios to solve the problem
 - Scenario 1: changes in the rules of informal credit
 - Scenario 2: changes in the rules of formal credit





Scenario I: current situation and rules

Scenario II: modified rules for informal credit (larger and mixed networks of villagers).



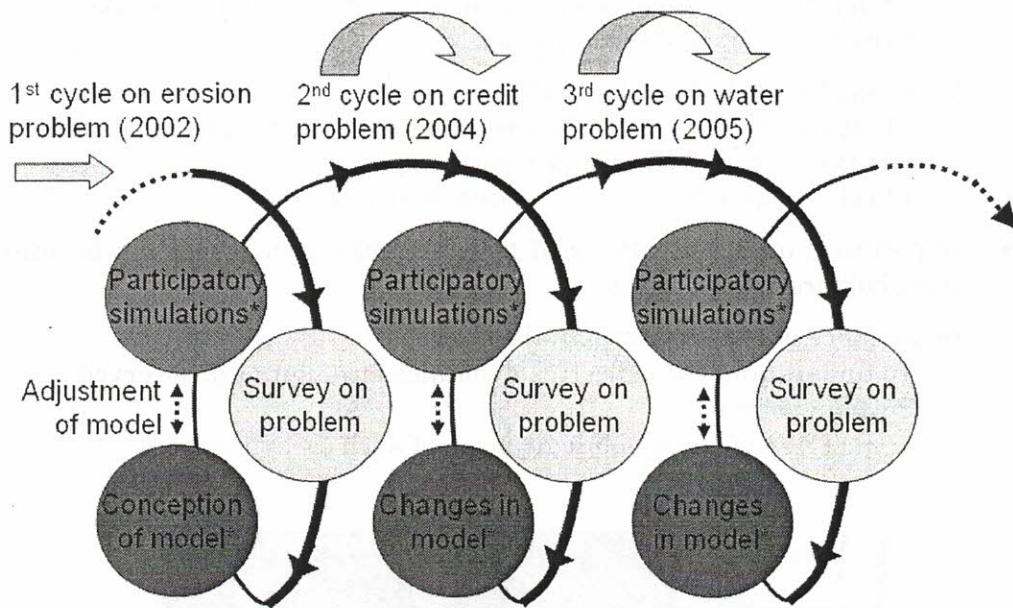
Scenario III: modified rules for formal credit (longer period for reimbursement and more equitable distribution).

Lessons

- What researchers learnt?
 - Understanding of decision-making processes, social networks
 - Critical analysis of the approach
- What local stakeholders learnt?
 - « Players can try by themselves, it is more efficient than speaking »
 - « In the game we can think together »
 - Effects on knowledge, perceptions, learning
- Importance of the flexibility of tools and researchers willing to adjust to stakeholders' perspectives
- Importance of the institutional context
 - To understand the collective dynamics stimulated & observed
 - To achieve impact
 - ...Question of the social legitimacy of such an experiment

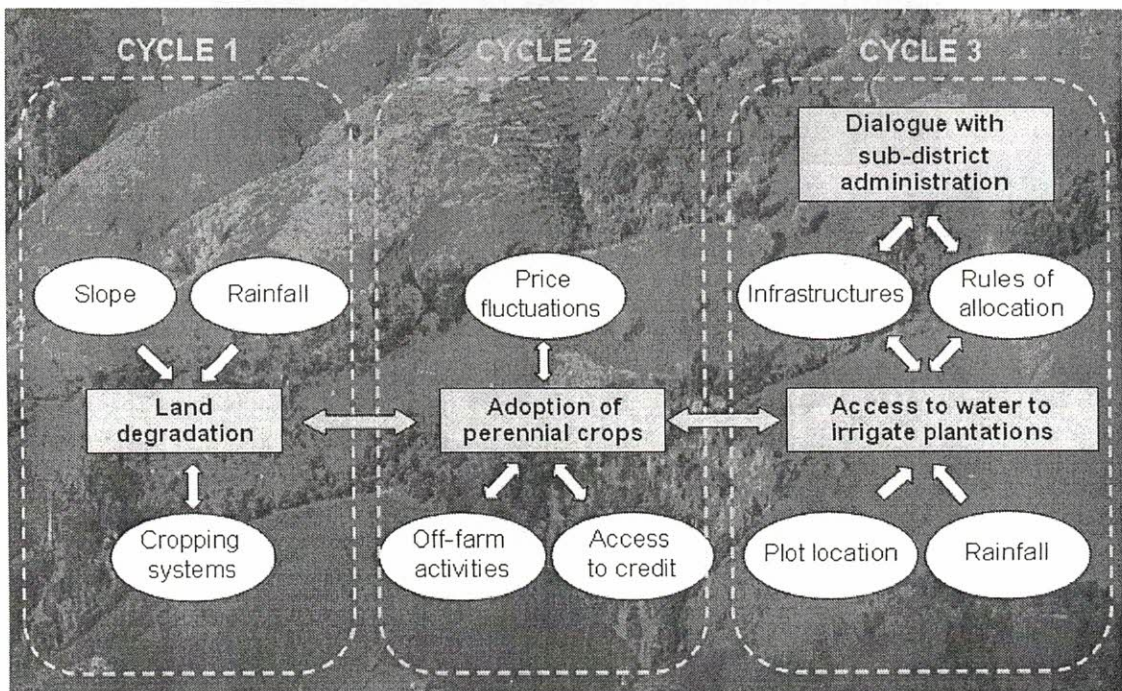


Mae Salaep methodology



* 1 conceptual model, 2 forms: Role-Playing Game & Multi-Agent System

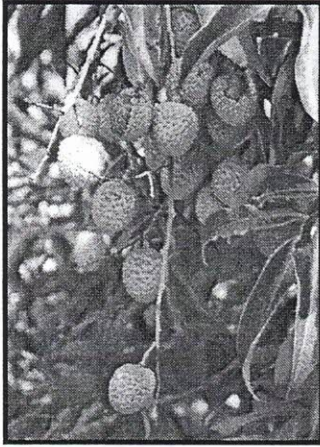
Evolution of the NRM question



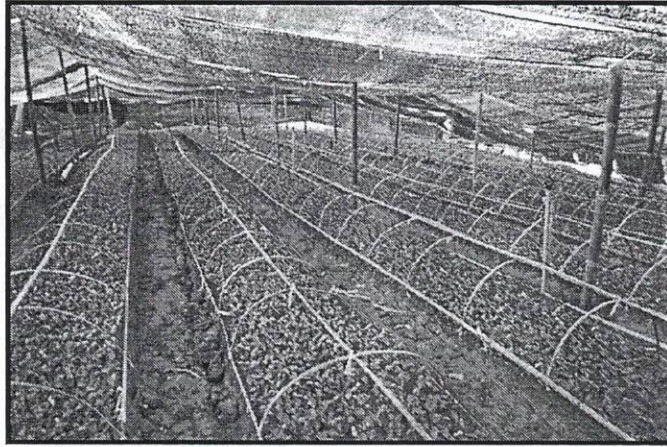
Adjustment of Role Playing Game and computer model to new focus

Water problem & power relations

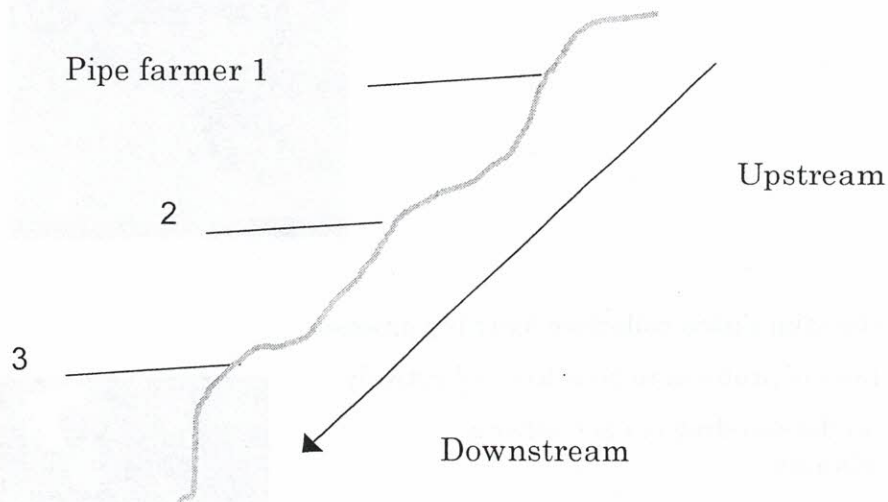
- Expansion of irrigated perennial crops
- Shortage of water
- Unequal access to water
 - « First arrived first served »
 - A majority of families with no access to water
 - Rule maintained by well-off families



Lychee



Oolong tea



Principles of the game



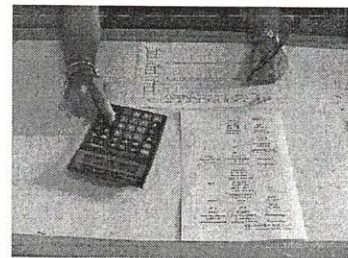
At « credit desk »
Decisions re. credit
& off-farm activity

At 3D board · watershed
Choice of crops
Decision re. irrigation

1 player =
1 farming household
with initial land,
labour force,
cash

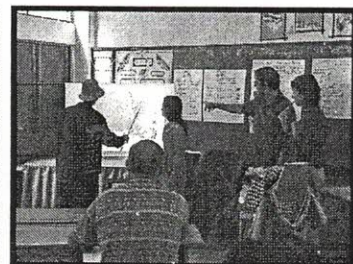
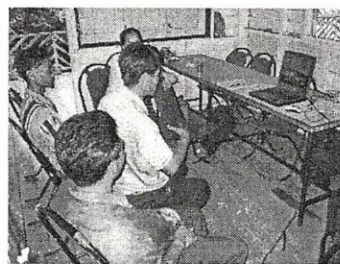
At « market desk »
Sell their products
& pay for expenses

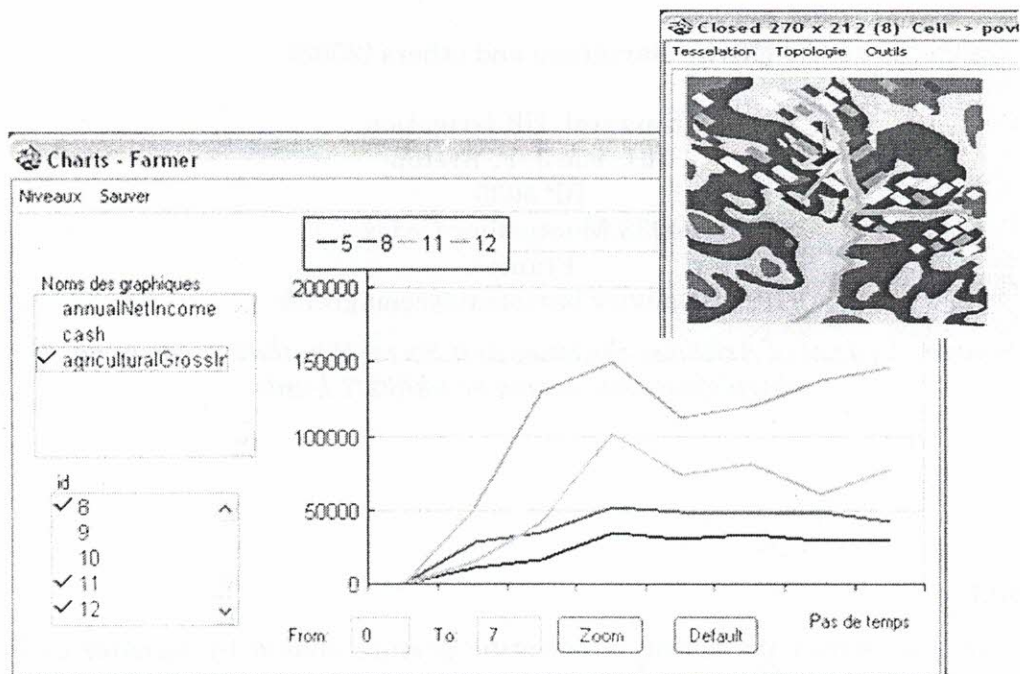
Observation of
interactions
among players



Analysis of the stimulated collective learning process

- Awareness of problem to be solved collectively
- Better understanding of each other's circumstances
- Exchange of perceptions on the problem
- Suggestion & negotiation of solutions
- Further negotiations through exploration of scenarios



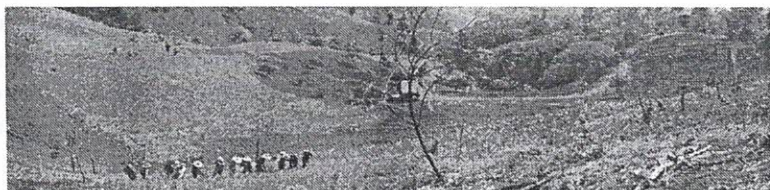


Discussion: ComMod & accommodation of multiple interests

- Horizontal interactions: leveled playing field
 - More self-confidence for the powerless, collective exploration of new rules with modified power relations
 - Identification of favouring elements
 - ⇒ Model & RPG highlighting differences
 - ⇒ Careful choice of participants (avoid exclusion)
 - ⇒ Be careful of first apparent consensus
 - ⇒ Individual interviews // collective debates
 - ⇒ Continuous & iterative process (discussions behind the scene)
- Limits when dealing with vertical interactions
 - No genuine bottom-up dialogue with TAO President
 - Lack of accountability of the TAO representative towards the community

Perspectives

- Ex-post evaluation of this Mae Salaep experiment (to be compared with many others from the global ComMod network)
- To use the lessons drawn from Mae Salaep experiment to conduct other ComMod experiments in the uplands of the GMS (and to draw new lessons from comparisons)



Our Companion Modelling Approach

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Source: Journal of Artificial Societies and Social Simulation vol. 6, no. 1

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Abstract

This paper is a charter presenting a scientific posture shared by signatories in the use of simulation tools when dealing with complex systems. This posture is based on a cycling approach, in interaction with field processes, including discussion of assumptions and feedbacks on the field process. Confrontation between field and modelling processes has to be permanent because of openness and uncertainty features of these systems. This approach is used with two possible aims: learn on systems or support collective decision processes in these systems, which corresponds to an objective of increasing knowledge either for the scientist or the field actors, always through an interaction between them mediated by an evolutionary model. Both aims lead to different implementations of this companion modelling approach, but each one is side effect of the other one, and has to be taken in account as such. Scientists ready to work in that way and make this posture alive are kindly invited to join.

Keywords: Cross-disciplinarity, Post-normal science, Mediation, Agent-based model, Role-playing game, Complexity

1. Introduction

- 1.1 The present signatories of this charter have worked for a number of years in the field of renewable resource management, using various tools, particularly Agent-Based Models and Role-Playing Games, to tackle issues regarding decision processes, common property, co-ordination among actors, etc. Working with models and games has been a mean to cross disciplines boundaries and to acknowledge the complex nature of the systems under study. This choice led us to formalise our relation to modelling within a companion modelling approach (Bousquet, Barreteau et al. 1999). At a time when models and simulations to tackle complexity and for decision support are flourishing, we found important to precise the contents of this approach, which should be understood as a scientific posture more than a modelling handbook. Modelling is merely an intermediary object (Vinck 1999) facilitating our collective and interdisciplinary thought.

2. The Team Posture

- 2.1 Our research activities are involved in the development process, and addressing genuine stakes and implementing them in the field is our preferred way to test and to question theories. We are dealing with a combination of pragmatic and theoretical questions regarding the management of renewable resources and the environment, and are facing complex and very dynamic research objects. Such a context leads to pay importance to uncertainty, and to the existence of multiple and legitimate points of view, including the ones produced by scientific expertise. These different view points deserve to be taken into account in an iterative process of understanding, confrontation, and analysis. Therefore, we have chosen to give ourselves a rigorous and refutable^[1] doctrine which could be evaluated. It means that:
- a. The fate of all the assumptions backing modelling work is to be discarded after each interaction with the field, that is to say to be voluntarily and directly subjected to refutation,
 - b. Having no *a priori* implicit experimental hypothesis is an objective implying the adoption of procedures to unveil such implicit hypotheses,
 - c. The impact in the field has to be taken into consideration as soon as the first steps of the approach, in terms of research objectives, quality of the approach, quantified monitoring and evaluation indicators.
 - d. Particular attention should be given to the process of validation of such a research approach, knowing that a general theory of model validation does not exist, and that procedures differing from those used in the case of physical, biological, and mathematical models need to be considered.
- 2.2 The present first version of this document ("Charter 1.0") results from a long discussion, and numerous common activities among its different signatories over the last two years. By definition, the present charter is an evolving one and will be periodically revised and updated with the agreement of its signatories. This is because struggling for rigor implies its improvement at each step, and striving for refutation leads to continuous questioning of our posture.

3. The Common Approach

- 3.1 In agreement with the complex and dynamic nature of the processes under study, our companion modelling approach requires a permanent and iterative confrontation between theories and field circumstances. Therefore, it is based on repetitive back and forth steps between the model and the field situation. Thus, this approach is adapted to the complexity and the openness of the systems under study because: i) it considers as legitimate and takes into account points of view which could possibly be contradictory, ii) it organises the compulsory questioning of any new element introduced in the approach, iii) during each loop, it confronts itself to new external elements.
- 3.2 Because in the field of cognitive sciences Multi-Agent Systems (MAS) are particularly adapted to the exploration of hypotheses presented as "true", and to the representation of dynamic and complex systems (Janssen 2002), this

simulation tool has been privileged in our approach and is used in association with other ones.

- 3.3 The importance given to field work in our approach leads to expectations regarding tangible effects at these sites. Depending on the experiences and tools used, the outputs could be of three kinds: the modification of perceptions, of behaviours, or of actions. Finally, one needs to distinguish between the use of this approach in two specific contexts: the production of knowledge on some complex systems, and the support to collective decision-making processes. While the first context corresponds to systems research *via* a particular relationship to field work, the second one corresponds to methodological research to facilitate a concerted management of such systems by proposing a particular relationship to field work to achieve such an end.

4. First Objective: Understanding Complex Environments

- 4.1 In this context, modelling deals with the dialectique among the researcher, the model and the field. Simulation accompanies an iterative research process, which is specific to each situation. The endless following cycle "field work-> modelling -> simulation -> field work again, etc." corresponds to this concept. This leads to accept a diversity of models and methods, each contributing to a new kind of relationship between the simulation, the research itinerary, and the decision-making process.
- 4.2 The researcher starts building a first preliminary model to explicit his/her theoretical as well as field-based pre-conceptions. The confrontation of this first model with real circumstances leads to revise and to re-build it, taking gradually into account the features of the field situation, but also the questions that stakeholders are asking to themselves. The discussion of the model hypotheses, and the simulations implemented according to an experimental plan corresponding to the initial questions, allows to modify the formers and to formulate new questions. This process leads to the construction of a new model, which is either derived from the previous one following its confrontation with the real circumstances and its evolution, or an entirely new one. As this cycle repeats itself, we create a family of models representing the successive interactions between the researcher and the field. There is no gradual *a priori* complexification of a model incorporating more and more elements to fit with "the reality".
- 4.3 Such a family of models is a genuine knowledge-based system allowing interacting researchers and stakeholders to increase their personal and common knowledge of the system, of the current processes, and of the situation of each actor-observer in such processes (Berkes and Folke 1998). Here, the key challenge of companion modelling is to deliver an improved understanding of these processes rather than a "turn key" itinerary for renewable resources management. As a consequence, there is a special relationship between the field and the model (*sensu lato*^[2]). Instead of proposing a simplification of stakeholders knowledge, the model is seeking a mutual recognition of everyone representation of the problematique under study. Such mutual recognition lies on indicators which are gradually and collectively built during the implementation of the approach, and constitutes the fundamentals of participatory modelling.

- 4.4 The underlying hypothesis is that, in most of the renewable resource management situations, what actors need is less a simple formalisation of their own perception than an exchange among stakeholders (including experts) about such representations, and existing knowledge. By structuring these exchanges, the simulation helps the stakeholders to validate the interactions between different representations and the system dynamics integrated in the model. A true learning process on the system under study is taking place through interactions with and among local stakeholders (Conein and Jacopin 1994).

5. Second Objective: To Support Collective Decision-making Processes in Complex Situations

- 5.1 In this case, the approach facilitates collective decision-making processes by making more explicit the various points of view and subjective criteria, to which the different stakeholders refer implicitly or even unconsciously. Indeed, as demonstrated in past research (Mermet 1992; Weber and Reveret 1993; Ostrom, Gardner et al. 1994; Funtowicz, Ravetz et al. 1999), when facing a complex situation, the decision-making process is evolving, iterative, and continuous. It means that this process produces always imperfect "decision acts", but following each iteration they are less imperfect and more shared. In other words, the question is not the quality of the choice, but the quality of the process leading to it. It is not about finding the best solution, but to take into consideration as well as possible the uncertainties of the situation. To improve the quality of collective decision-making processes, the approach aims at elucidating and sharing the points of view determining them. This approach refers to a dynamic perception of the decision-making process in which the scientific and technical perception is only one among others, and not the pre-supposed right perception toward which the decision should be attracted. The objective is not to ambitiously produce decisions and definitive results, but to enrich the decision-making process in terms of technical (information, technical quality of actions launched, etc.), or sociological (greater concentration, reinforcement of stakeholders power in making decisions, etc.) aspects. Because we are dealing with an evolving, iterative, and continuous process, the way to accompany it should also bear the same characteristics.
- 5.2 What tools can participate in such a process, and how to use them to accompany the collective decision-making dynamics? That is to say how to help stakeholders govern a situation along a continuous and gradually enriched itinerary, instead of proposing ready-made expert solutions? This is a situation similar to experimental approaches in post-normal science in which, based on a shared conception of the evolution of the current situation, the stakeholders can be collectively engaged in a process to take uncertainties into account (Funtowicz and Ravetz 1994). We propose the use of various tools to accompany and to support the decision-making process: MAS, role-playing games, geographic information systems, economic tools, etc. Depending on the situation, the production of knowledge or points of view on a given system could lead to: i) an improved knowledge of actors/decision-makers, ii) a facilitated dialogue among stakeholders (including experts) providing a framework for discussion and sharing of information, an exchange of viewpoints, knowledge, and beliefs among them, iii) a negotiation support system aiming at closing the gap between diverging points of view in a given conflicting situation.

- 5.3 Here, even if it is not covering the whole process of mediation by itself, companion modelling is taking part in it. Stakeholders learn collectively by creating, modifying, and observing simulations. When carrying out simulations one acts on the decision-making process by creating or modifying representations. Companion modelling leads stakeholders to share representations and simulations taking into account possible decisions and actions related to their environment which are under consideration (management rules, new infrastructures, etc.). Meanwhile, companion modelling does not include the other possible steps of the mediation process dealing with a more quantified expertise (size of a new infrastructure, estimated production, etc.). Companion modelling intervenes upstream of the technical decision to support the reflexion of concerned actors, in order to produce a shared representation of the problematique, and to identify possible ways toward a process of collective management of the problem.

6. A Joint Use

- 6.1 We consider that the organization of action is a result emerging from a dynamic of interactions among individual and/or collective stakeholders. Such a dynamic is constrained by the understanding and perception that every actor has of others' actions, therefore of his own indicators concerning the environment he is sharing with others. Consequently, it is fundamental to distinguish rigorously between the two above-mentioned kinds of use of our approach, even if in practice they are often implemented simultaneously. The first kind of use looks for its scientific legitimacy in the production and relevance of knowledge, while the second one aims at improving the quality of collective decision-making processes.
- 6.2 In both cases, there is production of knowledge through the interaction among researchers and local stakeholders. But in the first situation, this production of knowledge (being for researchers, or for local actors through training activities) is the objective, while in the second case we make the hypothesis that it is a necessary element of the method to achieve the main objective of supporting collective decisions. This distinction is as much a methodological question than a epistemological and analytical one: nothing can guarantee that the tools and the methods tested in a given situation will be useful, efficient, and adapted in another one, particularly regarding the posture of the researcher-modeller in the process. This is why we tackle these two modelling problematics differently. On the other hand, we think that it is necessary to consider them jointly, because the points of view produced by each of the two modelling situations are useful to elucidate the secondary effects created by one of them.

Signatories

If you are interested in this approach and would like to join the group of signatories of this charter to participate to their forum, please register at the Cormas website (<http://cormas.cirad.fr/en/reseaux/ComMod/index.htm>).

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Patrick d'Aquino (geographer CIRAD),
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Olivier Barreteau (water scientist Cemagref),*

Stanislas Boissau (sociologist CIRAD),
 François Bousquet (modeller CIRAD),
 William's Daré (sociologist Cemagref)
 Michel Etienne (plant ecologist INRA),
 Christophe Le Page (modeller CIRAD),
 Raphaël Mathevet (animal ecologist Tour du Valat),
 Guy Trébuil (agronomist CIRAD),
 Jacques Weber (economist IFB).

Notes

¹ In research, refutation is the only rigorous expression of intellectual freedom, particularly in the ambiguous context of action-research.

² Here, from verbal diagnosis to computer models, all possible types of dialogues between the researcher and the stakeholder are considered as, more or less formal, participatory modelling processes. As a matter of fact, in all cases, a representation is built, shared, and made formal in a particular way: "unconscious" modelling (purely verbal participatory diagnoses, expert cognitive representations of the situation, etc.), and more explicit models (maps, information systems, computer models, etc.).

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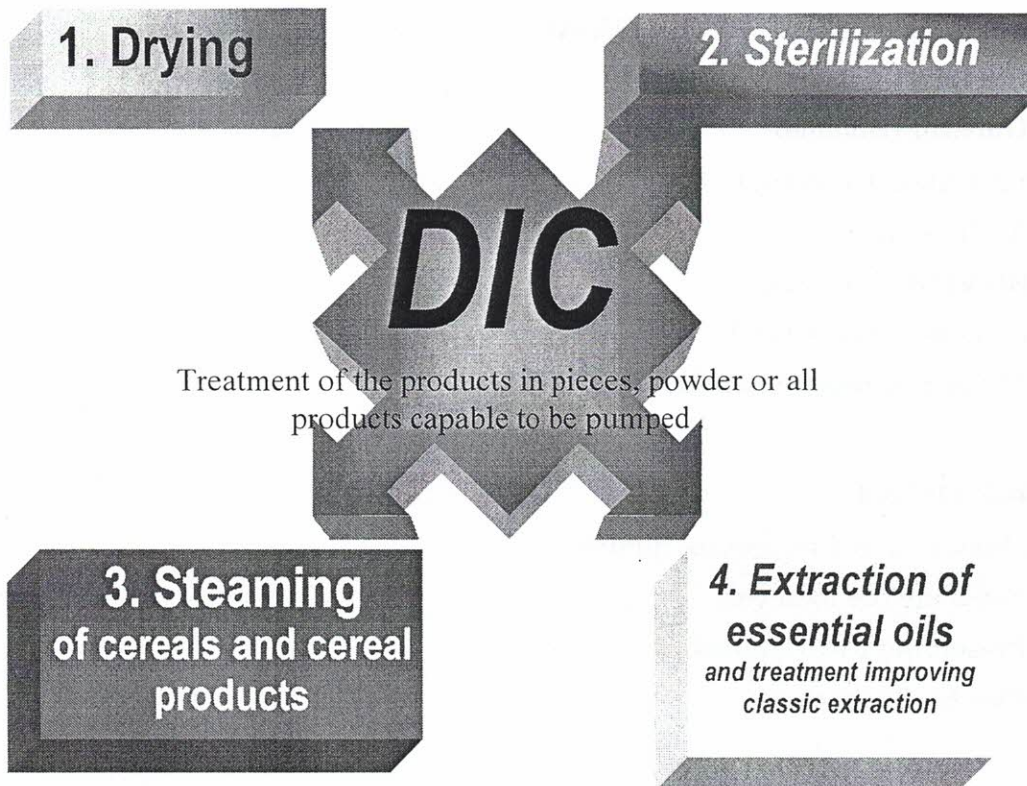
WEBER J and REVERET J-P (1993) Biens communs : les leurres de la privatisation.
Le Monde Diplomatique, coll. *Savoirs*, 2. pp. 71-73.

Technology of Instantaneous Controlled Pressure - Drop (Détente Instantanée Contrôlée) DIC®

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Technology of Instantaneous Controlled Pressure-Drop DIC



Close collaboration with:

- Several industrial Companies
- Food industry
- Pharmaceutical
- Perfume
- Cosmetic

- European Community
 - 8 European projects
- National and International Academic cooperation
 - UTC (France)
 - Mc-Neese University (Louisiana-USA)
 - Universidad de Mexico
 - UBAYA University (Surabaya – Indonesia)
 - CanTho University (Vietnam)
 - Lebanese University (Beirut - Lebanon)
 - University of Bucharest (Romania)

Creation of innovative Companies:

- ABCAR-DIC Process (France);
- Legni & Segni (Italy)

Various Industrial realizations and Productions:

- Universal Foods (California - USA)
- Coralma (France)
- Unilever (Holland)
- Protekum (Germany)
- AZTI (Spain)
- BONTOUT (France)
- Contento trade (Italy)

DIC = 17 years of research and 21 Ph-D works...

Characteristics

- Mastering and Improving quality
- Reducing the total cost
- Preserving Environment
- Flexible Technology

How to define the DIC technology?

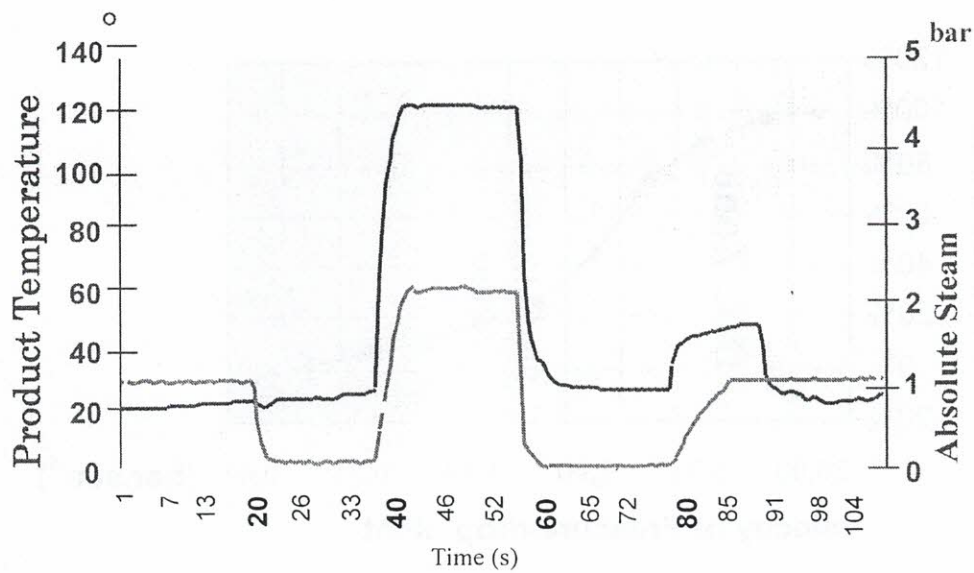
- Principle
 - Abrupt Pressure-Drop APD toward vacuum
 - following a (HTST) treatment
 - High Temperature (high pressure) Short Time treatment
- Impacts

APD provokes

 - an Sudden autovaporization *generally texturing/swelling polymers as foods, ...*
 - Controlled expansion
 - ⇒ Instantaneous cooling!

The 4 stages of DIC treatment:

- 1- To institute a primary vacuum.
- 2- To set high steam pressure and maintain HT/HP (~5bars)
- 3- To impose an Abrupt Pressure-Drop APD toward vacuum;
- 4- To put atmosphere pressure.



Process:

Perfectly controlled Process

Products:

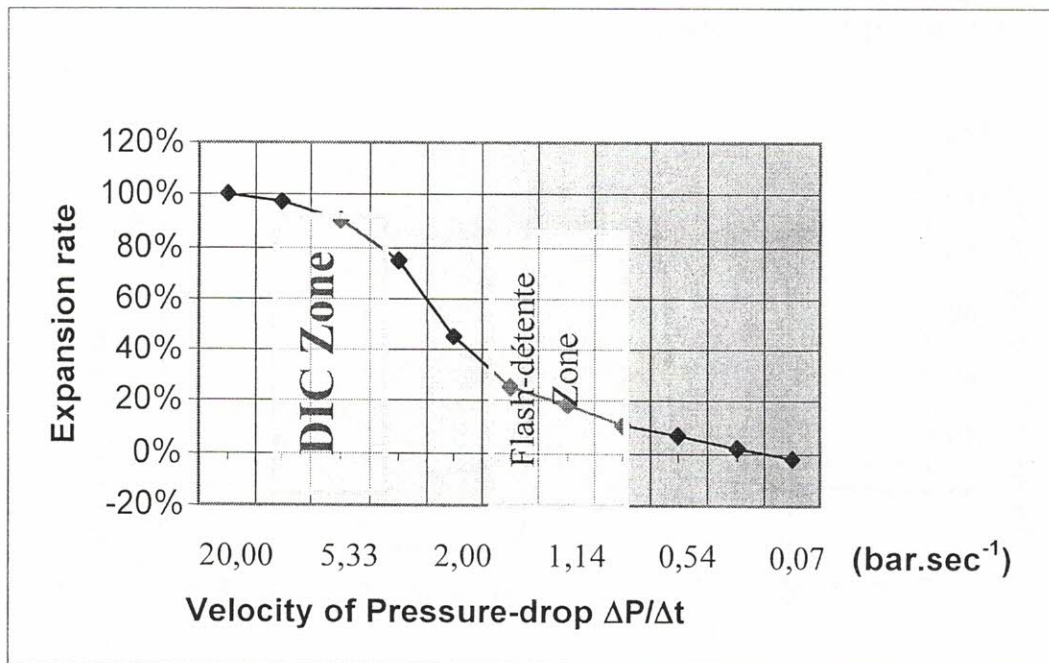
Large range, high quality

Industrial Reactors:

Several types of industrial reactors of 50kg/hr to 8 tons/hr.

What does "Instantaneous" mean?

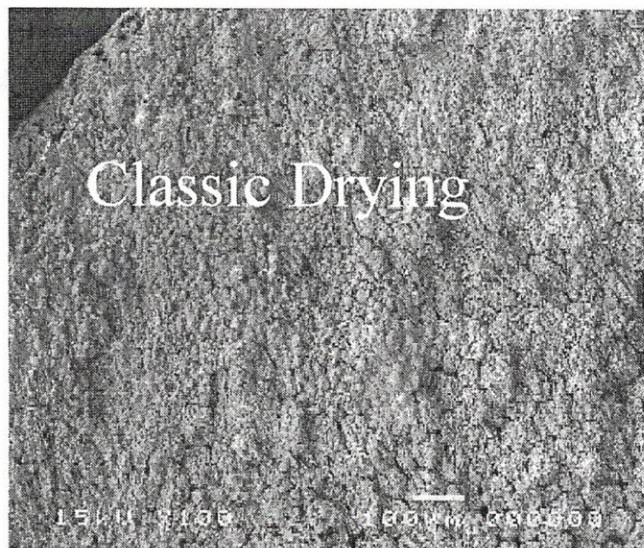
Or how intervenes the velocity of dropping the pressure ?



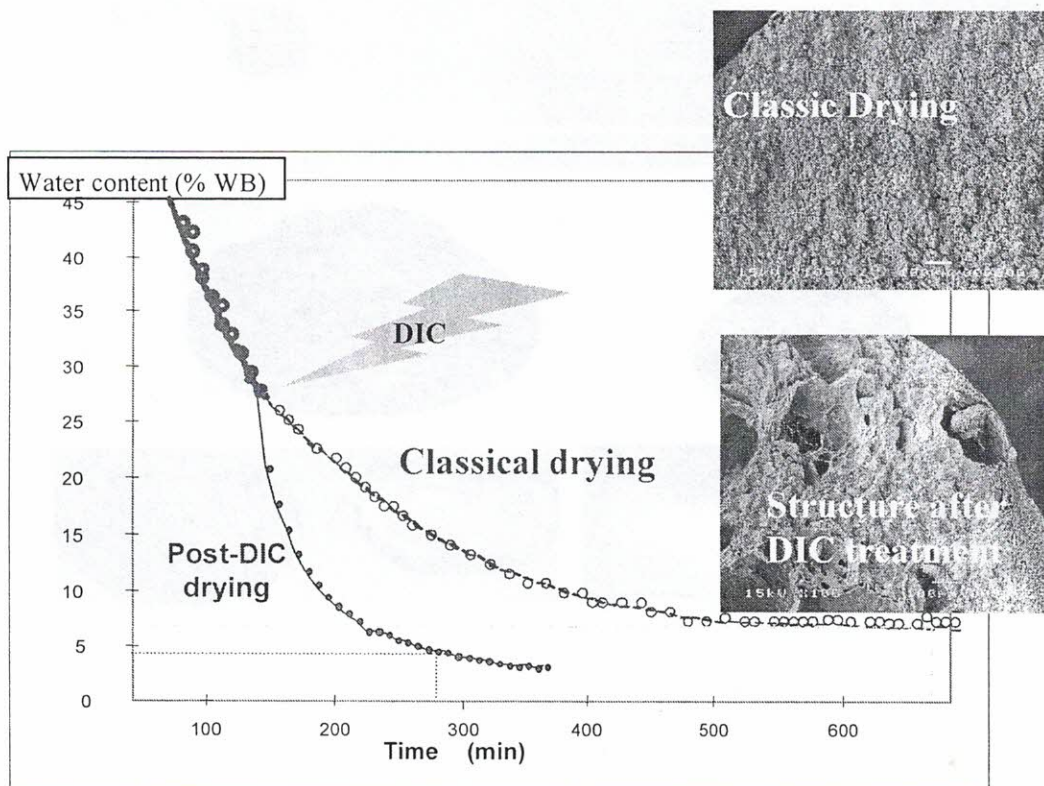
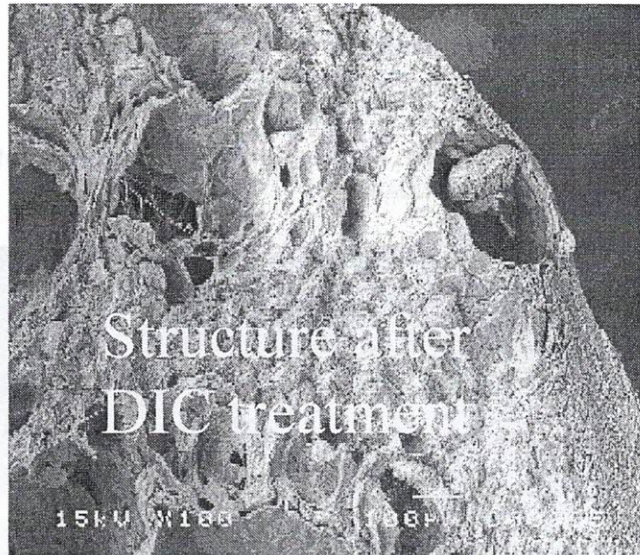
SWELL - DRYING By DIC TEXTURING

of fruits, vegetables, alga, herbs, cereals, ...

Note that shrinkage during the first stage of drying (industrial hot air or even artisan solar drying) notably decreases the kinetics of the final drying stage! It implies a great thermal degradation!!!

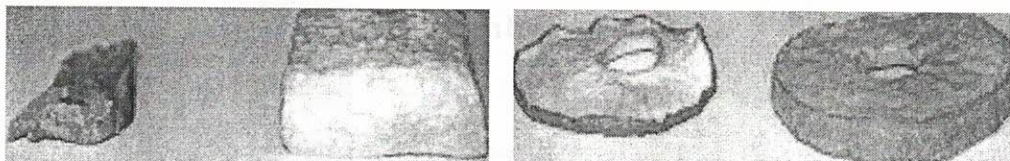
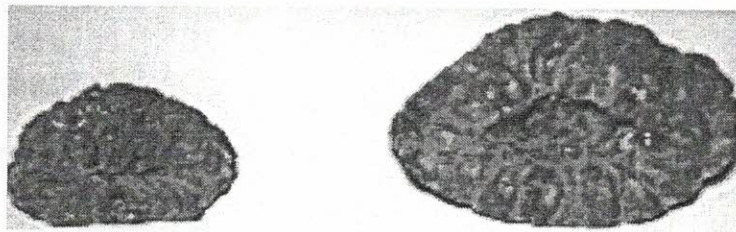
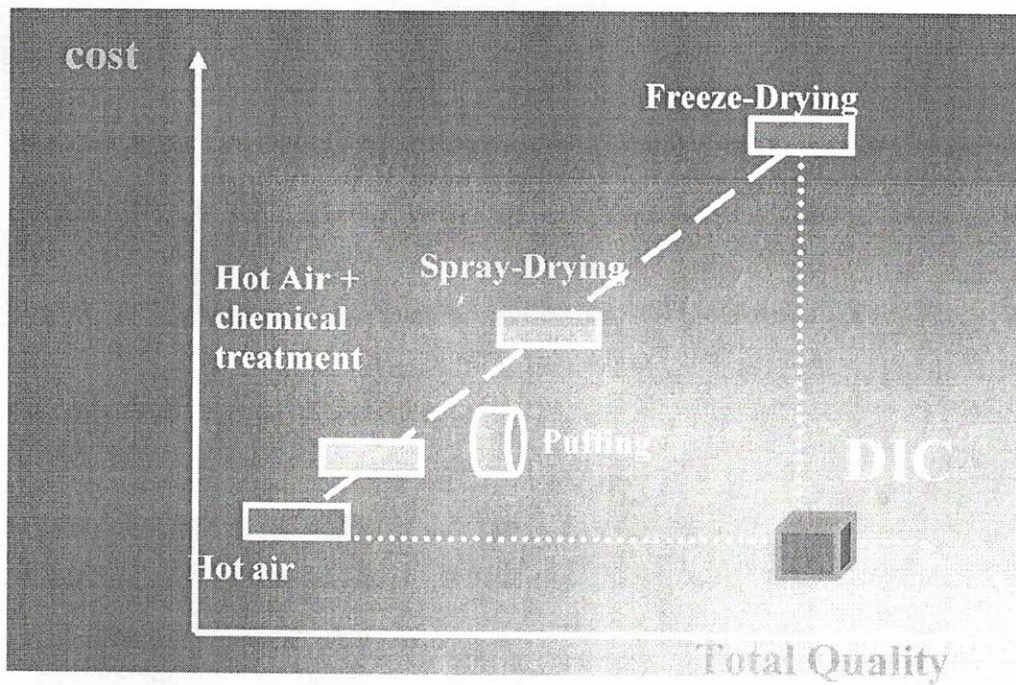


The only manner to remedy to this situation consists in modifying the new compact structure: an adequate DIC treatment allows us to eliminate the distortion of material and to get high kinetics during the final stage of drying.

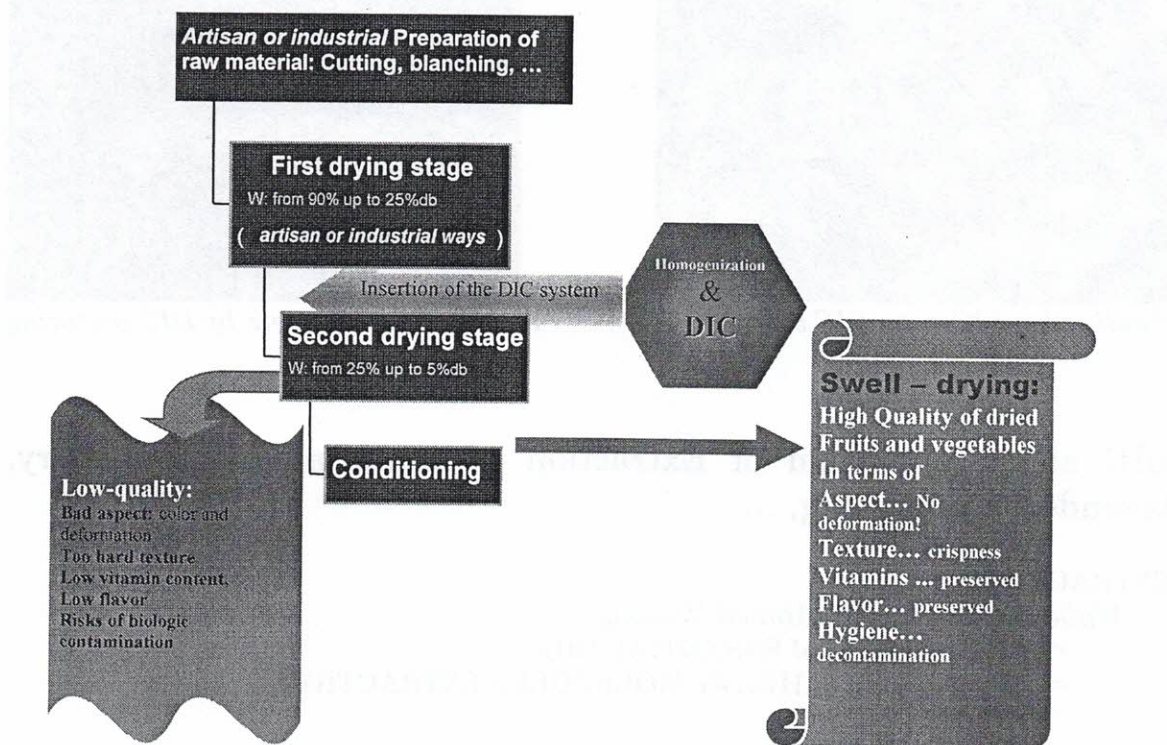


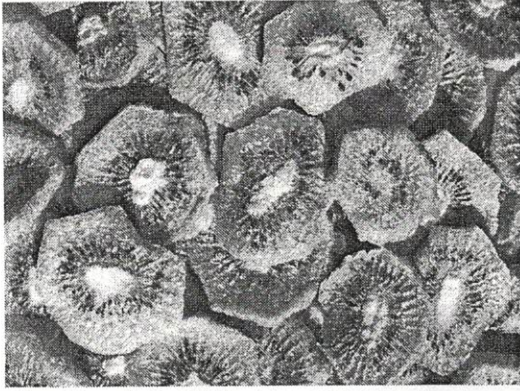
It distinguishes itself by

- ⇒ *Absence of the distortions,*
- ⇒ High kinetics of re hydration,
- ⇒ Preservation of the main organoleptic contents,
- ⇒ Good sterilization.



How to improve the quality of the dried Fruits and vegetables and the drying process?
By inserting the DIC into a traditional drying process





Swell – dried Kiwi by DIC texturing



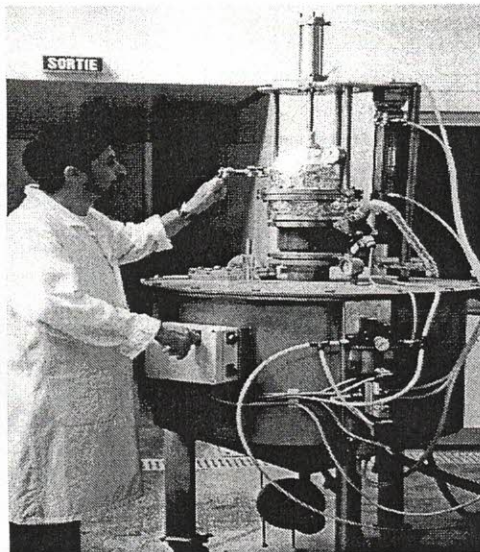
Swell – dried Peppers by DIC texturing

DIC as an operation of Extraction of essential oils Rosemary, lavender, ylang ylang, ...

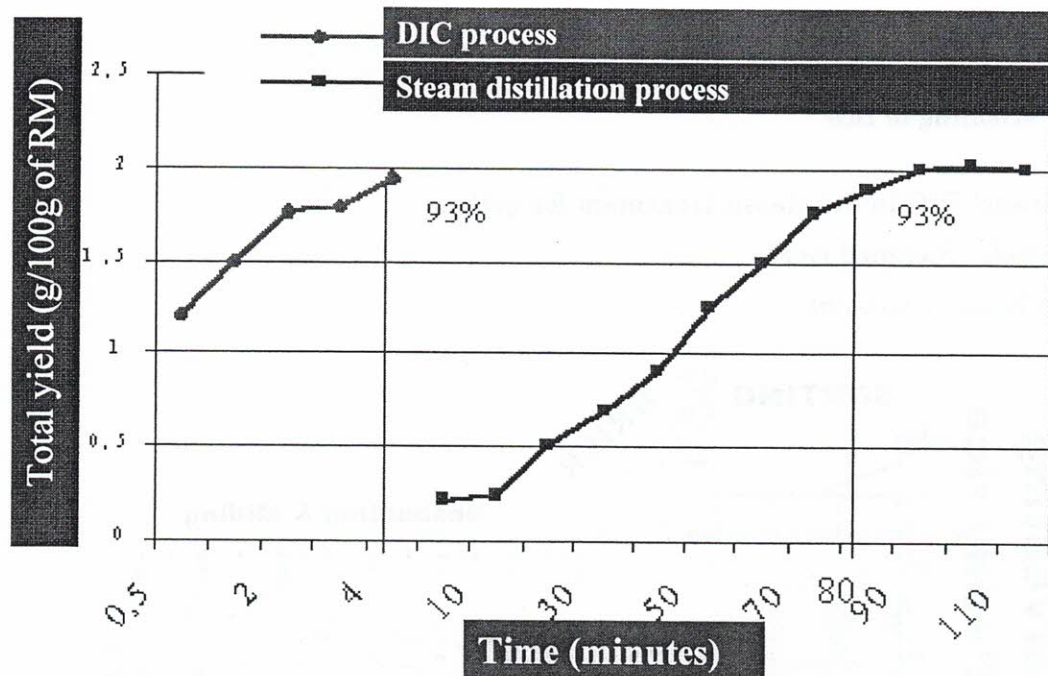
EXTRACTION

Walid Baghdadi et SidAhmed Rezzoug

- ☞ EXTRACTION of ESSENTIAL OILS
- ☞ Improvement of HEAVY MOLECULES EXTRACTION



Pilote DIC



EXTRACTION of ESSENTIAL OILS by DIC

DIC Advantages

☞ Extract Quality

Absence of solvents in the extracts.

Absence of thermal degradations of extracts.

☞ Environment Impact

Absence of solvents.

Reduction of water consumption and residual products.

☞ Operation Cost

Low energy consumption *

Example:	rosemary		
Essential oil content	2%		
METHODS	Energy Consumption		Time required for extraction
	kWh per kg of treated raw material	kWh per kg of extracted Essential Oil	
Steam distillation			
Industrial tests	1 to 25	50 to 1250	1 à 24 hours
Laboratory tests	2.6	130	~ 60 minutes
Extraction by solvent			4 to 16 hours
Concrete (extraction primary solvent)	6	300	
Absolute	4	200	
Total	10	500	
Extraction by supercritical fluids (CO ₂)	2	100	1 to 8 hours
Extraction by DIC	0.6	30	1 to 10 minutes

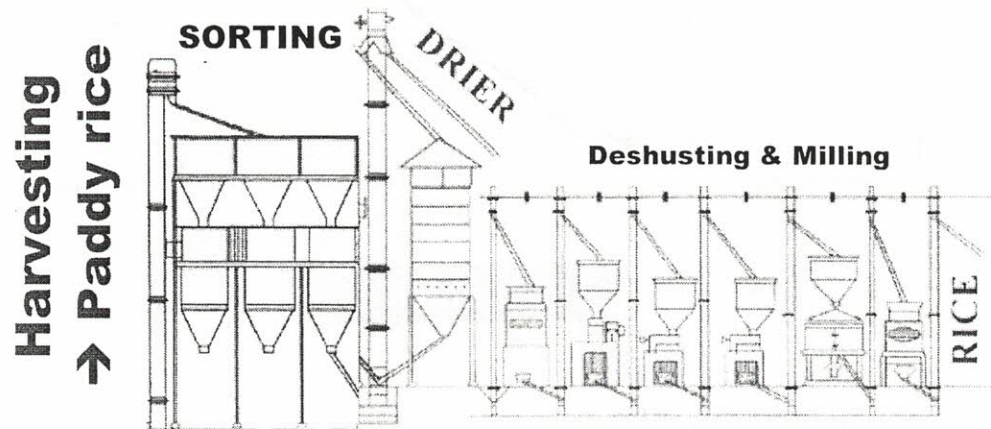
DIC in the operations of

1. Steaming &
2. Parboiling of rice

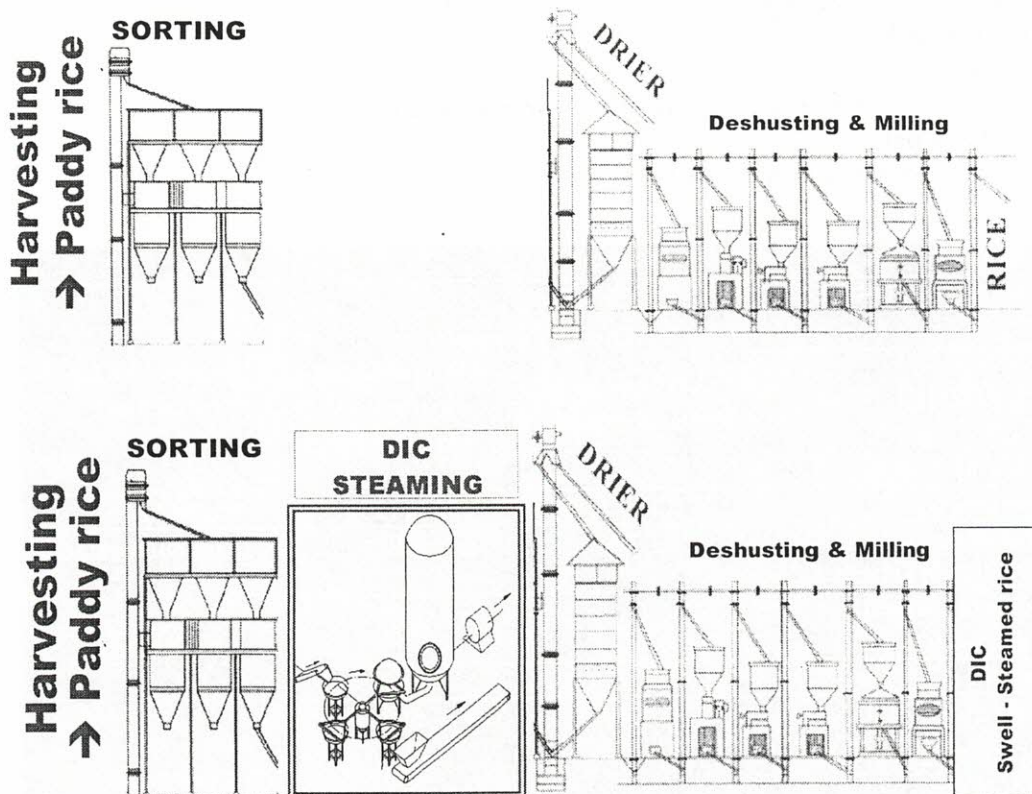
How to insert DIC in the classic treatment for getting

1. DIC Swell - Steamed rice?

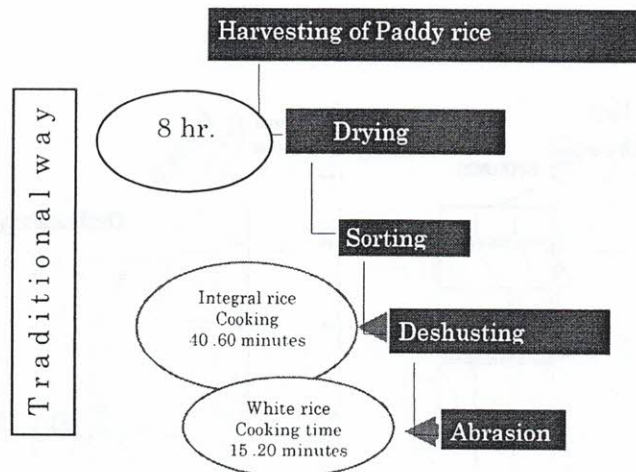
1.1. Classic treatment:



1.2. DIC Swell - Steaming:

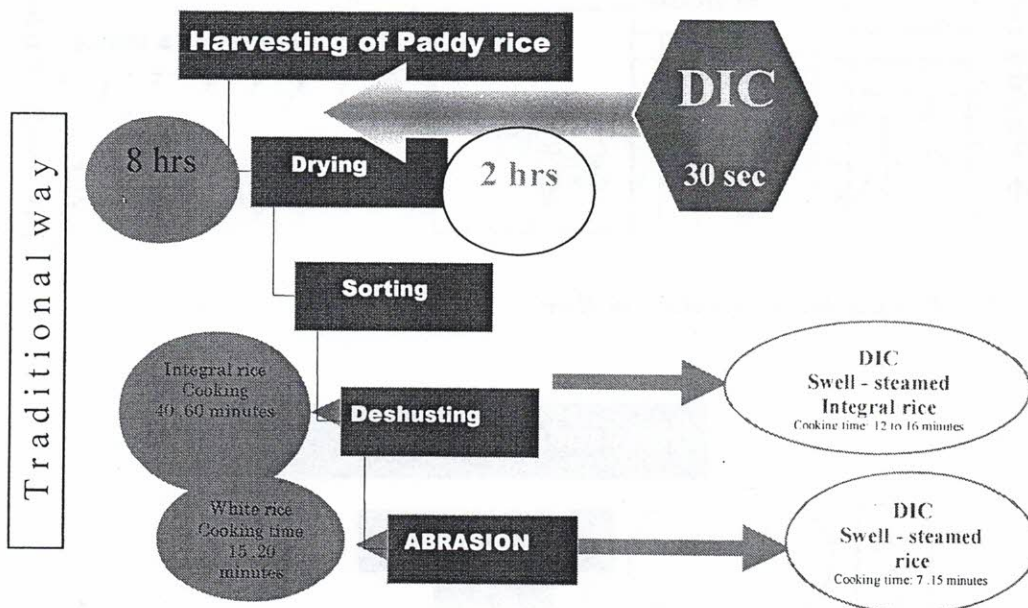


- Traditional treatment of Rice



Rate of broken rice 10 to 38%

- DIC Swell - steaming of Rice

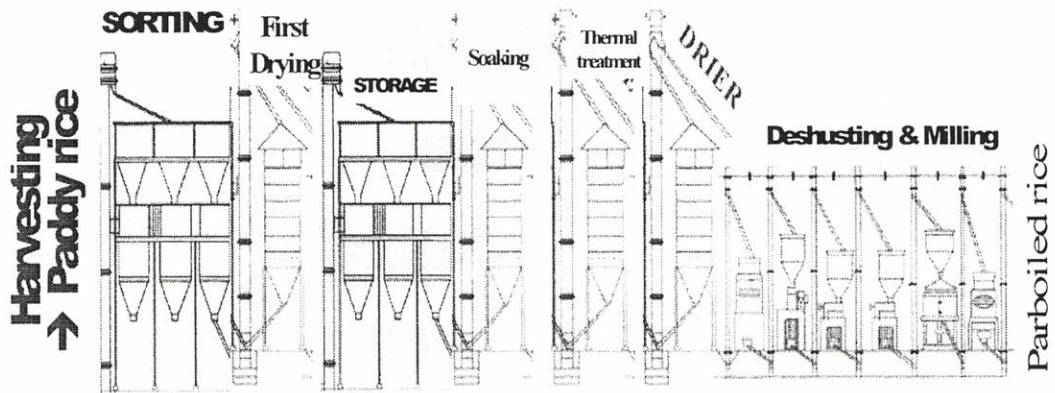


Rate of broken rice 10 to 28%

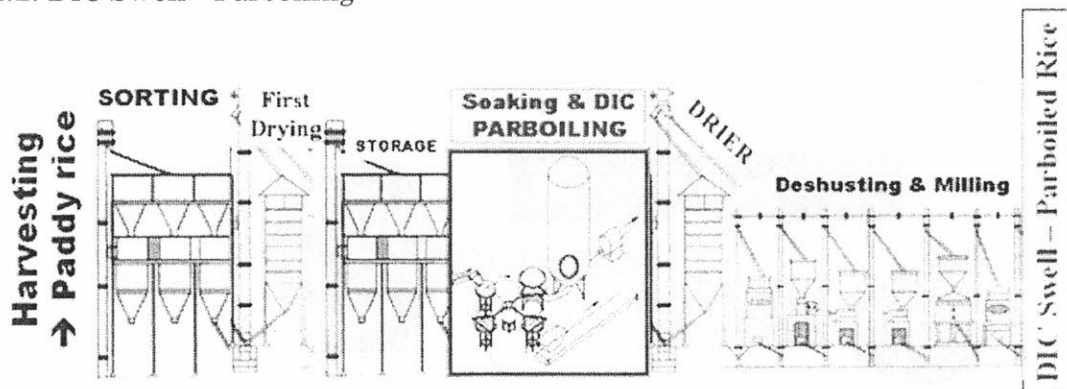
Rate of broken rice 1 to 3%

2. DIC Swell - Parboiled rice?

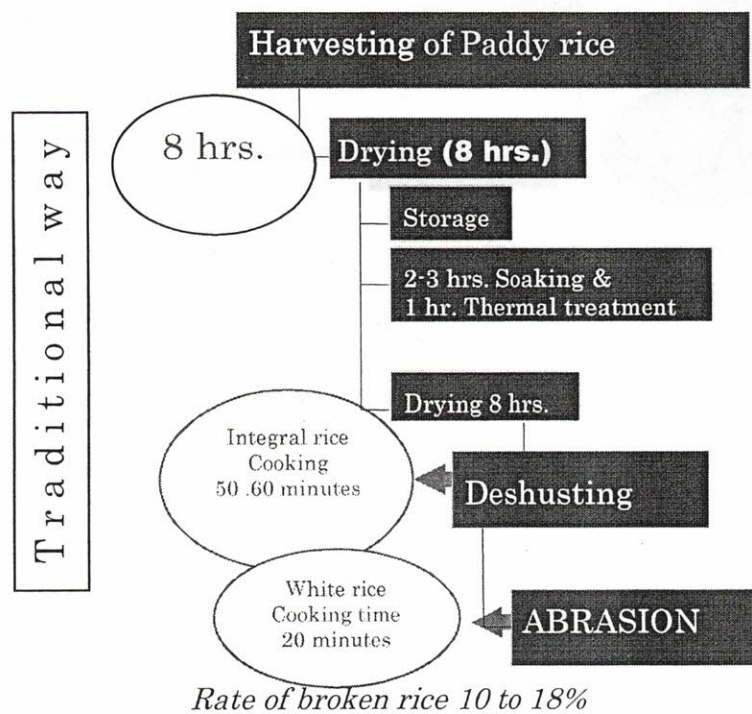
2.1 Traditional - Parboiling:



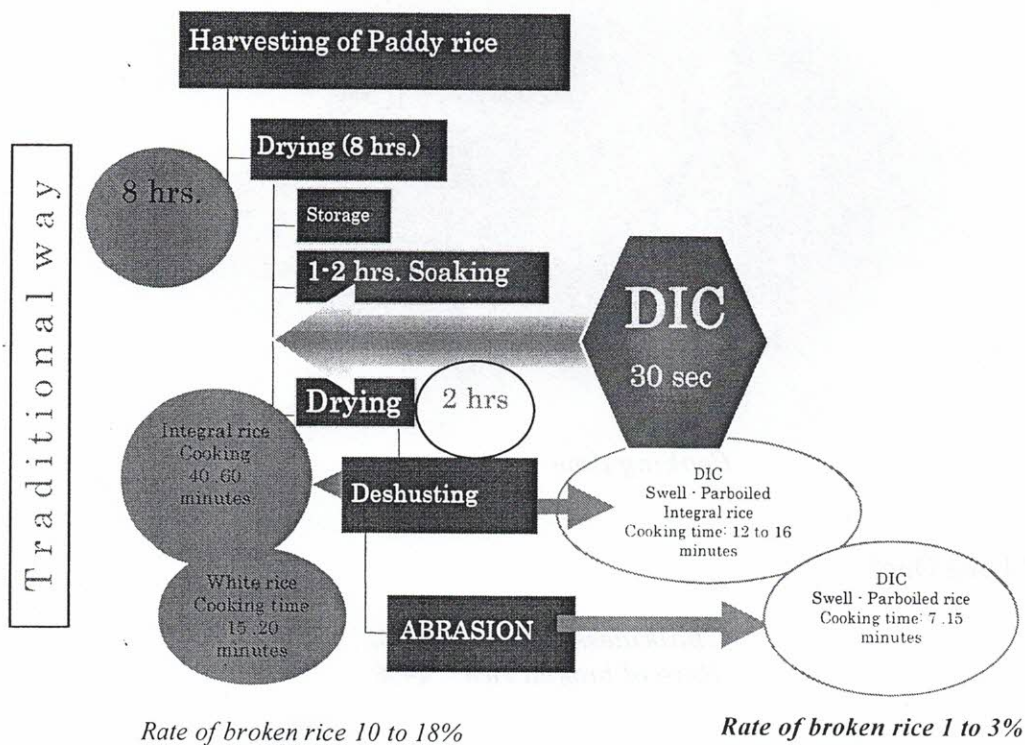
2.2 DIC Swell - Parboiling:



- Traditional Parboiling of Rice



▪ *DIC Swell - Parboiling of Rice*

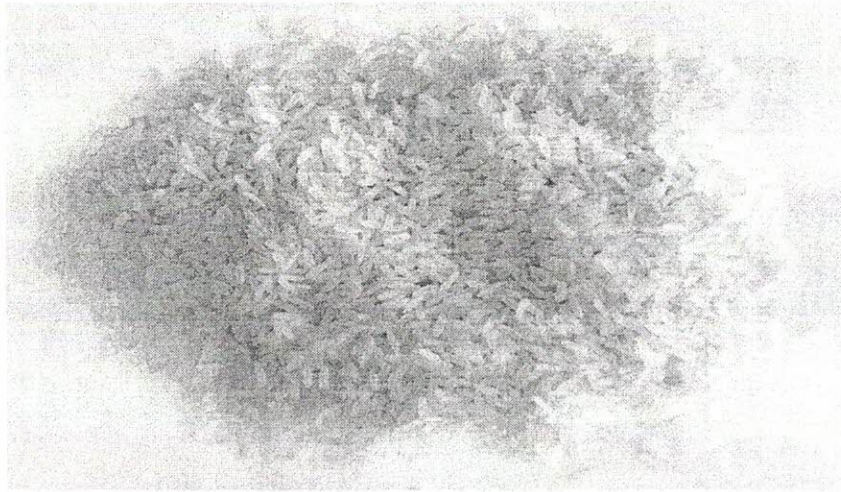


CP02 variety, Chau Phu 2
(Aromatic variety Giang, VIETNAM);

Rate of broken rice 17.2%



Rate of broken rice < 3%



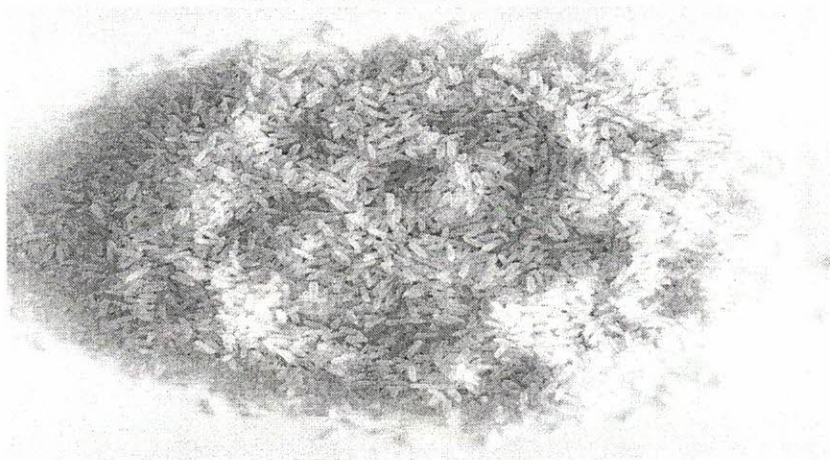
Cooking time 7 - 9 minutes

Variety" Long One"

Chalkiness rate 25%;
Rate of broken rice 44%



Chalkiness rate 0%
Rate of broken rice < 3-6%

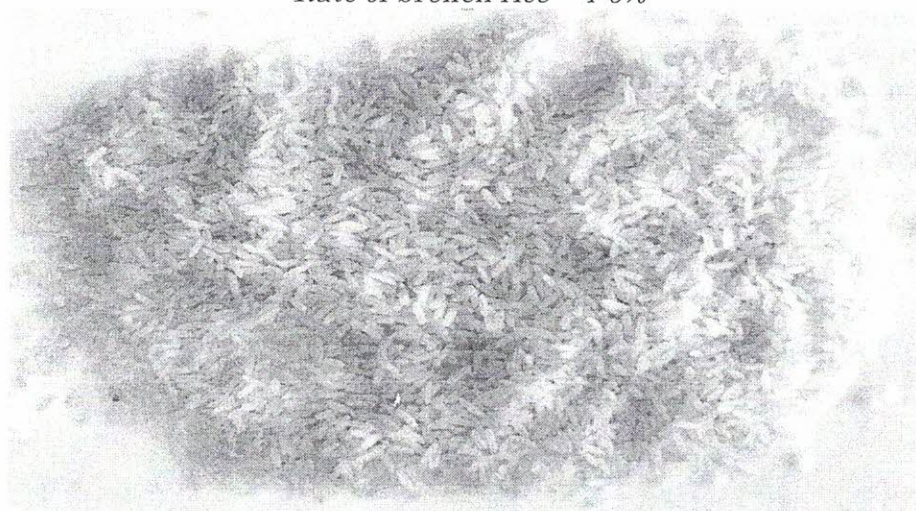


Cooking time 7 - 9 minutes

Rate of broken rice 49.4%



Rate of broken rice 4-6%



Cooking time 7 - 9 minutes

Conclusion concerning rice

From «Sectorial survey post-harvest of rice in the Mekong Delta»

Study realized by AFD for PHTI of HCMC

				Export1	Export 2	
Yearly theoretical	5760	28800	28800	28800	57600	ton/year
Yearly real capac:	2707.2	13536	13536	13536	27129.6	ton/year
% Whole grain	62.41%	69.25%	70.37%	66.00%	65.00%	% Whitened rice
% Broken grain	37.59%	30.75%	28.40%	29.00%	30.00%	% Whitened rice
% Whole grain	41.50%	47.30%	45.60%			% paddy
% Broken grain	25.00%	21.00%	18.40%			% paddy
% Bran	10.00%	9.70%	13.00%			% paddy
% Hust	20.00%	20.00%	20.00%			% paddy
Lost	3.50%	2.00%	2.20%			% paddy

Vietnamese "Export" path of rice needs:

- to adopt a "high quality steamed rice"
- to reduce the rate of broken rice
- To diversify varieties (importance of aromatic rice, different cooking times, etc.)
- To homogenize final products

→ *Highly important place of DIC!!*

Sterilization by Controlled Instantaneous Pressure - Drop

Thermo-mechanical destruction by DIC of the micro-organisms in solid products in pieces or in powder.

Thesis of doctorate of Miss DEBS - LUCAS

Material and methods

➤ Biologic material model

Microbial stumps deposited on a solid support filter paper

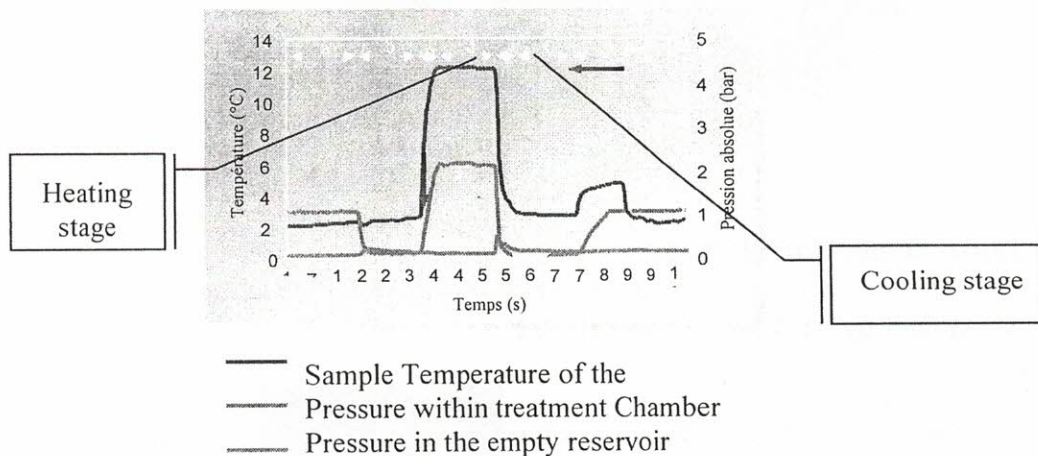
- *Bacillus stearothermophilus*
- *Enterococcus faecalis*
- *Escherichia coli*
- *Saccharomyces cerevisiae*

➤ Application

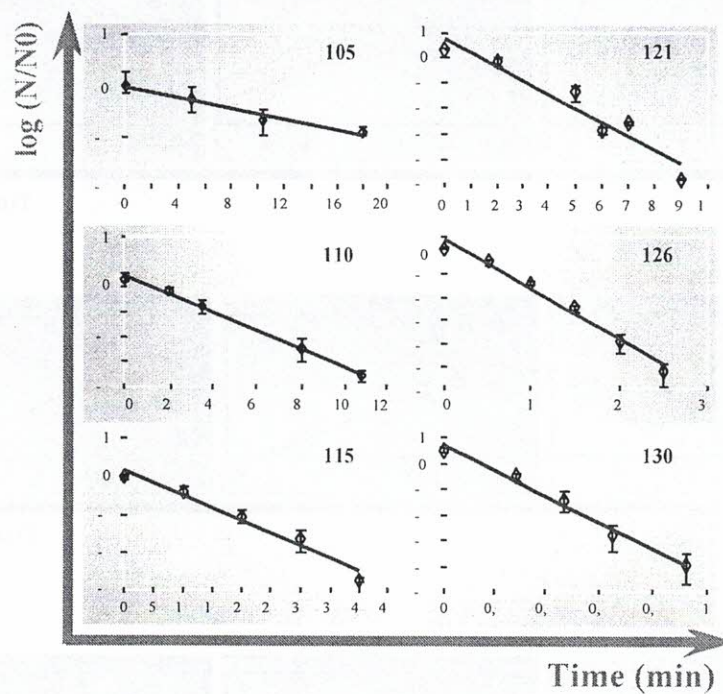
Numerous Foodstuffs thermally fragile

Kinetics of microbial destruction by DIC

Profile of a thermal DIC treatment

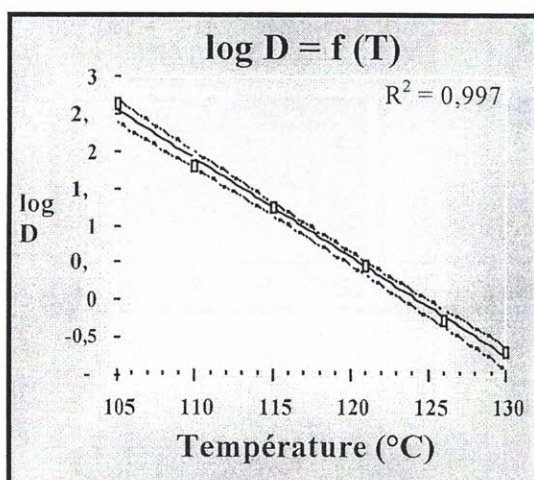


Kinetics of microbial destruction by DIC of the Bacillus stearothermophilus spores



Results and discussion

Kinetics of microbial destruction by DIC/HTV of the Bacillus stearothermophilus spores



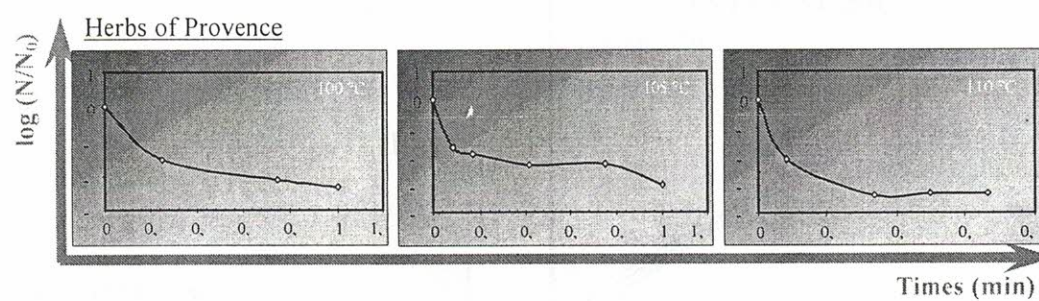
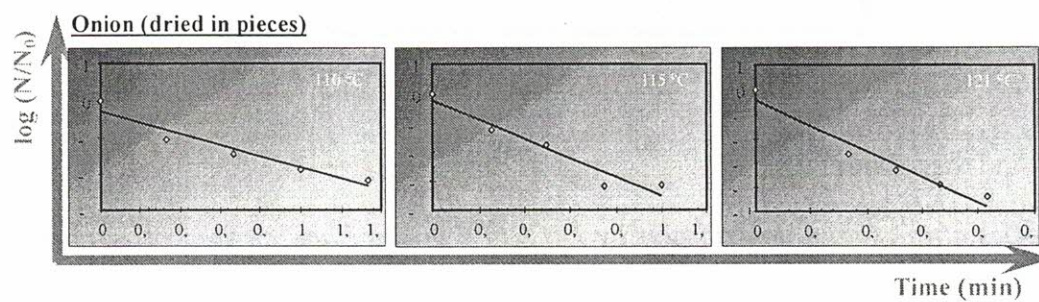
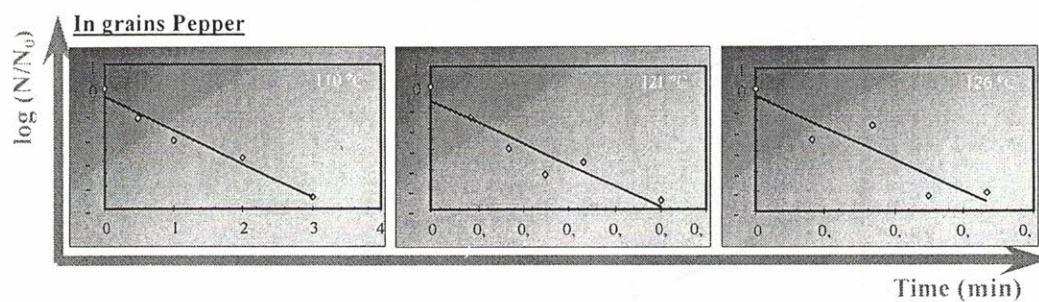
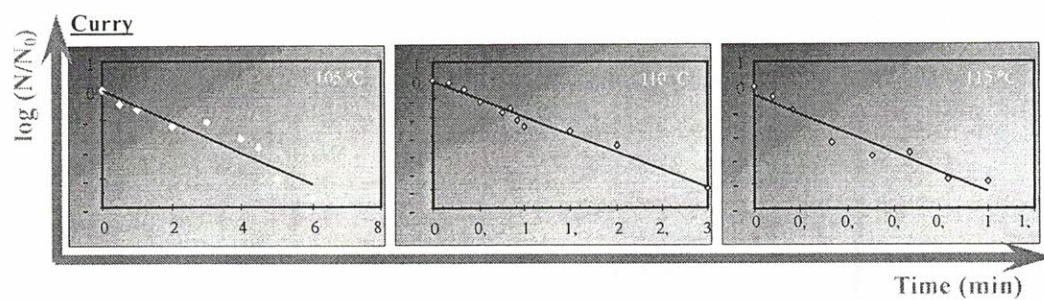
$$D_{121,1^{\circ}\text{C}} = 2,6 \text{ min}$$

$$z = 7,6^{\circ}\text{C}$$

$$D_{121,1^{\circ}\text{C}} = 4,2 \text{ min (Lejean, 1996)}$$

Microbial destruction by DIC in foodstuffs

- Provence Herbs,
- Black pepper in grains
- Dried in pieces Onion
- Mixture of green herbs
- Curry
- etc.

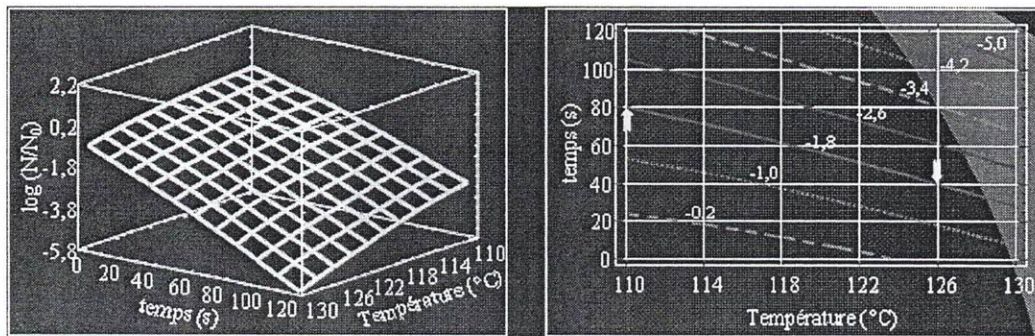


Results and discussion

Microbial destruction by DIC/HTV in foodstuffs

Experience Design in the case of the black in grains pepper

Central composite plan T (°C). [110; 130] and t (s). [20; 120]

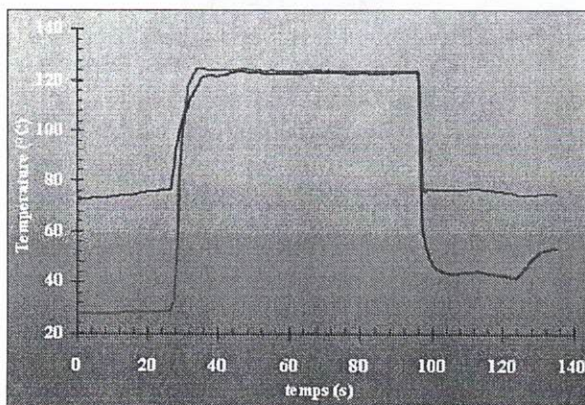


$$R^2 = 0,96$$

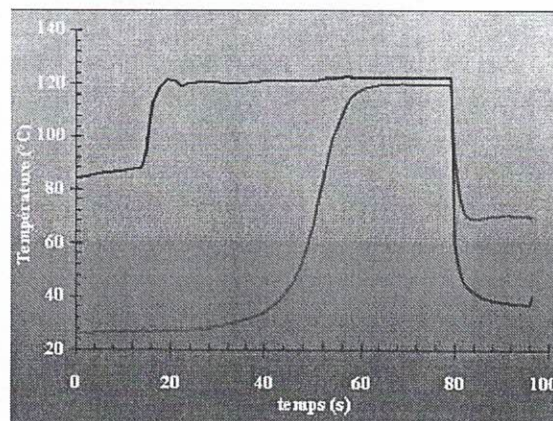
Thermal diffusion

Case of the black in grains pepper

Thickness of layer = 5 cm



Thickness of layer = 9 cm



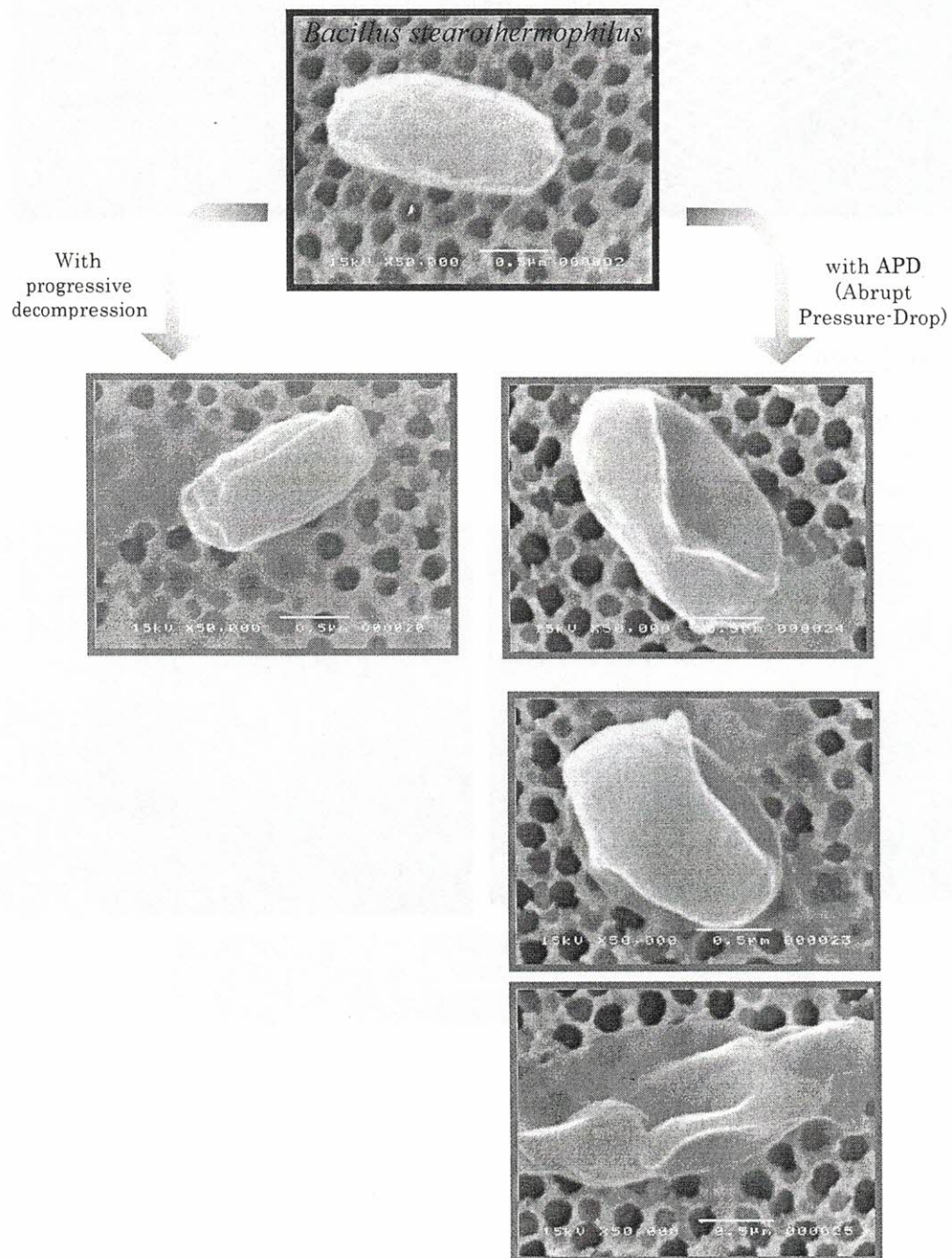
— Temperature of the treatment chamber
 - - - Temperature of the geometric center of the sample

Results and discussion

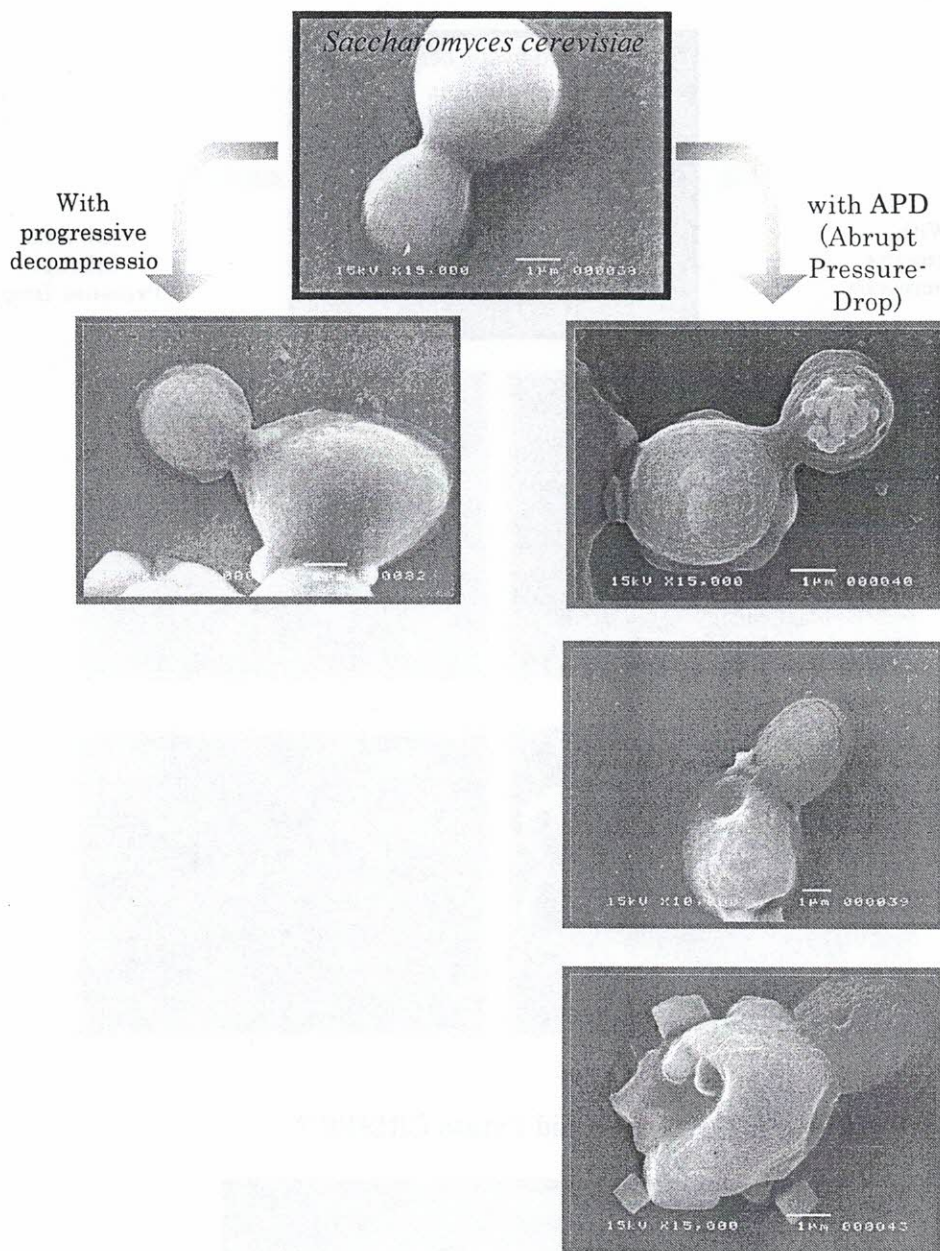
What is the mechanical impact of the DIC toward vacuum?

Impact of the Abrupt Pressure-Drop toward vacuum on the microbial structure

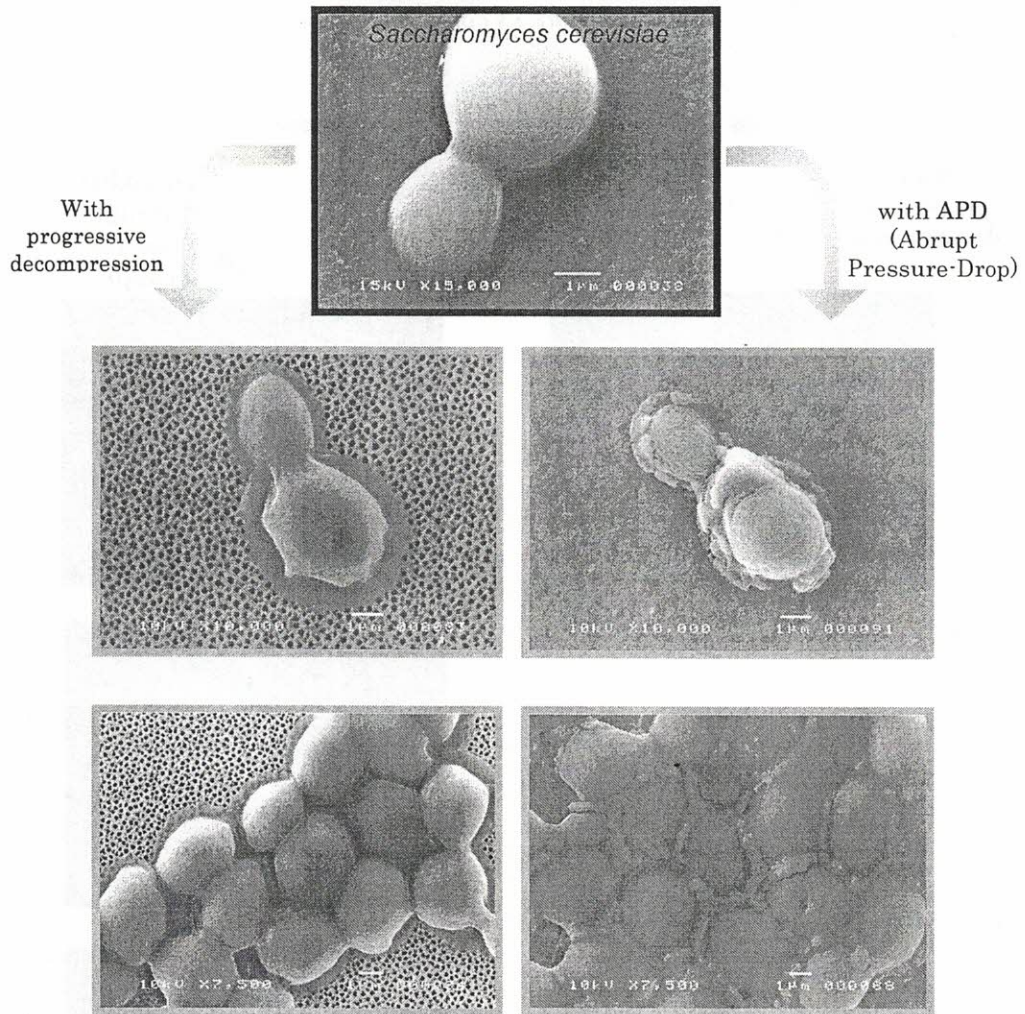
Thermal treatment (130°C; 30 s)



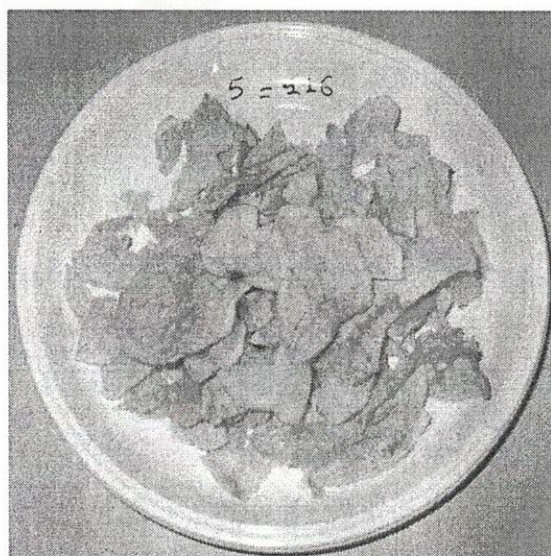
Thermal treatment (105°C; 30 s)



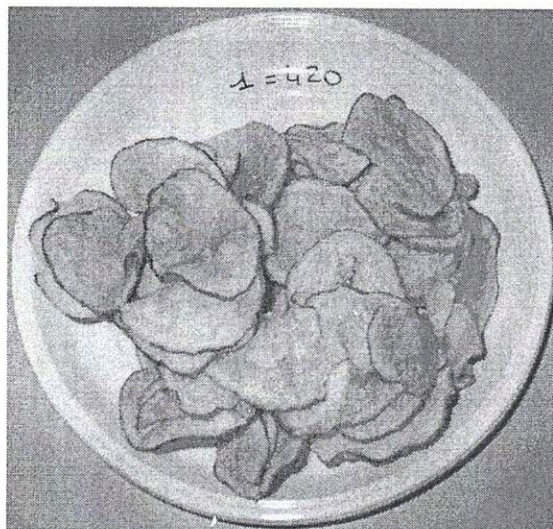
High pressure CO₂ Treatment (55 bar ; 5 h)



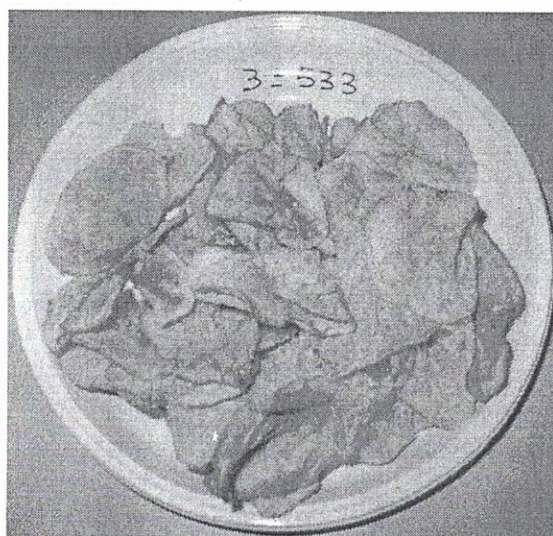
Is it possible to produce "Free acrylamid Potato CRISPS"?



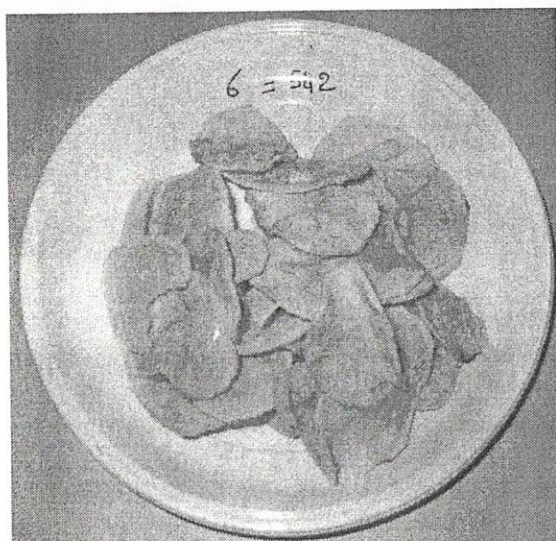
116 ABCAR Products : 1% Oil, Thickness 2mm



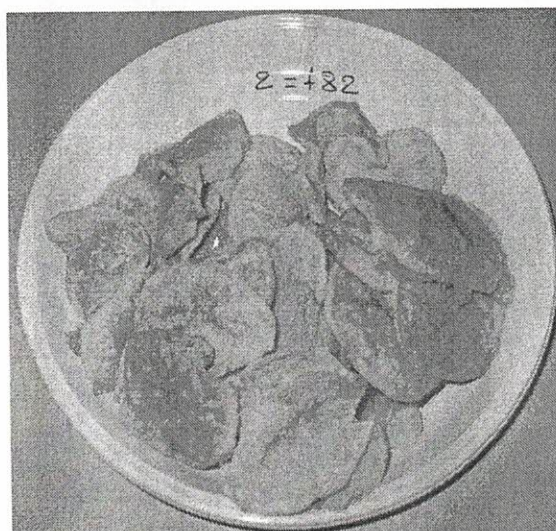
*420 ABCAR Products :
additive :1% oil + 1% Sal, Thickness 2mm, presence of skin*



*533 Products ABCAR:
additive: 1% Oil + 1% Sal, Thickness : 5mm*



542 ABCAR Products : Thickness 2mm



*782 ABCAR Products :
1% Sal, Thickness 2mm*

Problem of acrylamide in food products

FOOD	Content in acrylamide (µg/kg)
Fried, baked potatoes, Shabby pancakes of potato	60 to 3500 even 12800 for the "burnt"
Cookies and industrial pastries, grilled bread, toasts, crackers,	30 to 3500
Breakfast Cereals	30 to 1350
Crisps of corn	30 to 450
Almonds smokes and grilled	230 to 460
Soft bread	30 to 160
Coffee	17- 260
Crisps, cookies aperitifs,	170 to 3100

Problem of acrylamide in food products

Potato Crisps Trade product	810 µg/kg
--------------------------------	-----------

DIC Products

Potato DIC CRISPS 1	< 30 µg/kg
Potato DIC CRISPS 2	< 30 µg/kg

Is it possible to produce "Free acrylamid Potato CRISPS"?

YES!
...by DIC Technology

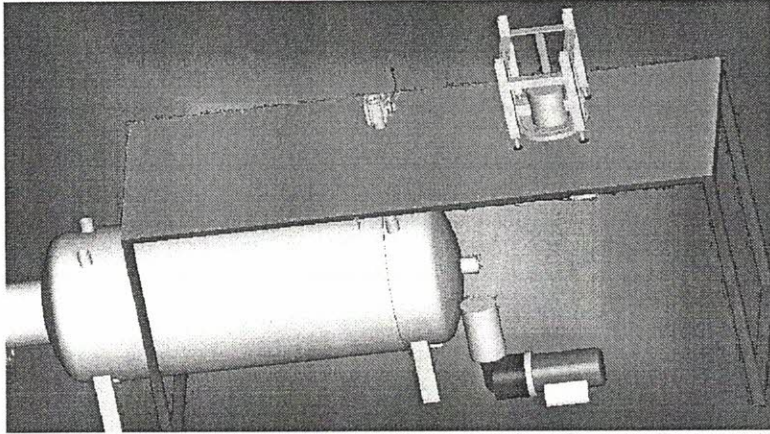
Machines DIC:

- Laboratory scale: DIC-LAB-1
- Industrial equipment:
 1. DIC-TUBular-15
 2. DIC-LINear-1 and Manual – DIC LINear – 2
 3. DIC-SELF-LUBricating
 4. DIC-DIAGonal
 5. STATIC-DIC
 6. DYNAMIC-DIC

DIC-LAB-1

- ✓ Laboratory system, 1 liter treatment Chamber
- ✓ Condensers.
- ✓ Ideal for extraction, chemical analysis of biologic materials, better recuperation of cellular contents, etc.
- ✓ Treatment of polymers, fruits, vegetables.
- ✓ Definition and optimization of various industrial processes: Drying/Texturing by DIC, extraction, etc.

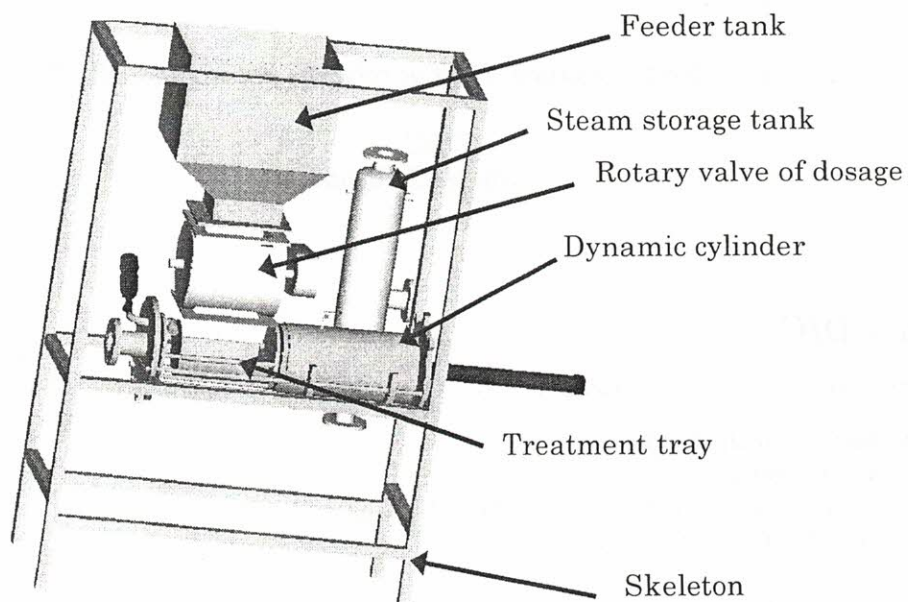
DIC' Lab system



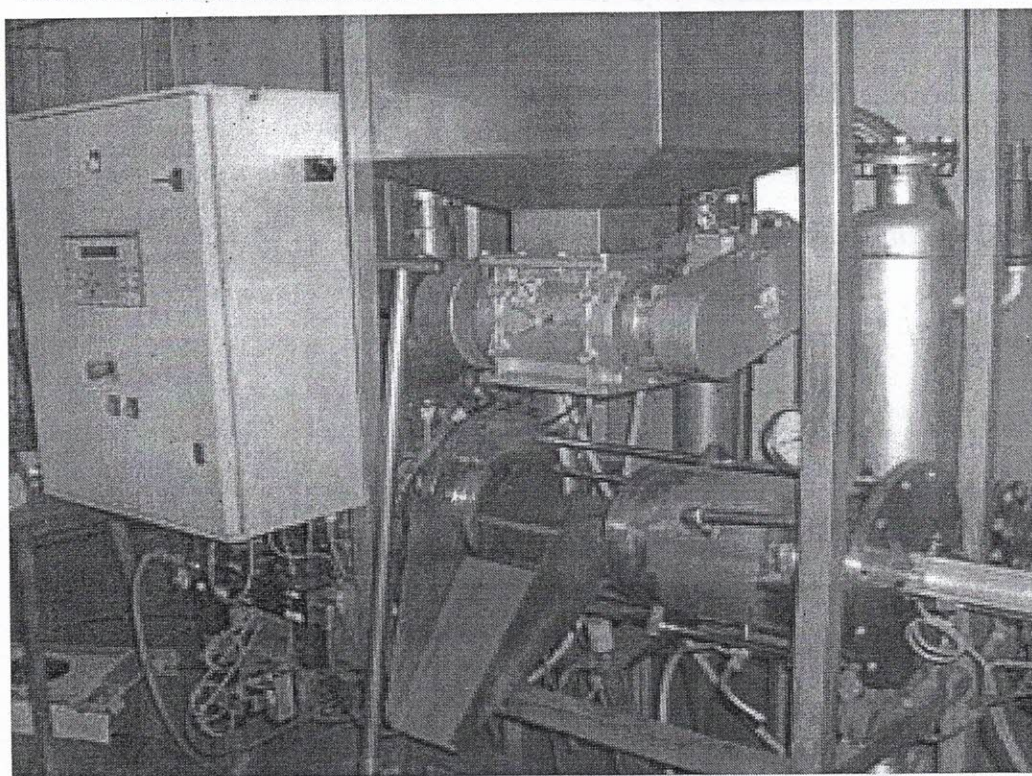
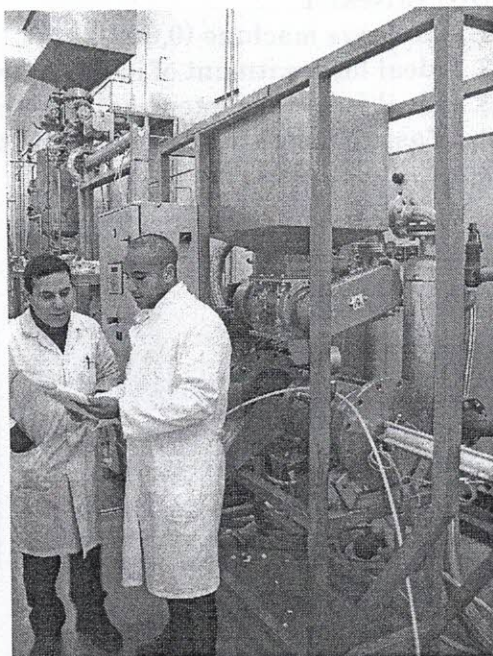
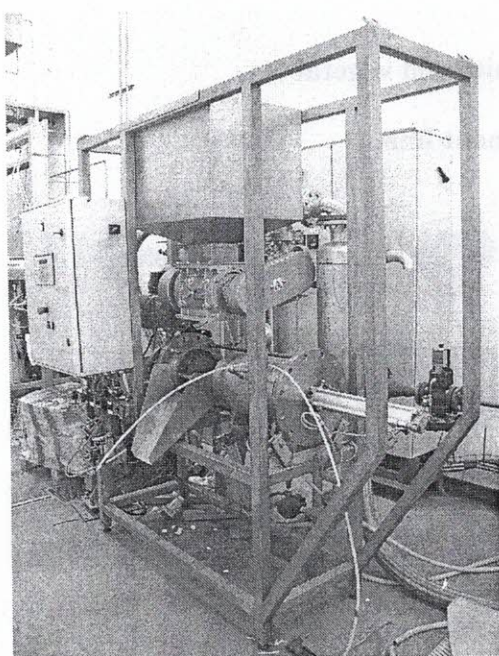
1. DIC-TUBular-15

- Smallest industrial Machine (between 50kg/h and 120kg/h)
- Ideal for sterilizing powders, herbs, in pieces products
- May be used for extraction processes.

Self-blocking reactor



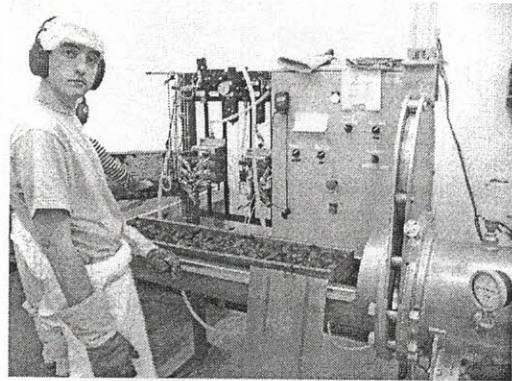
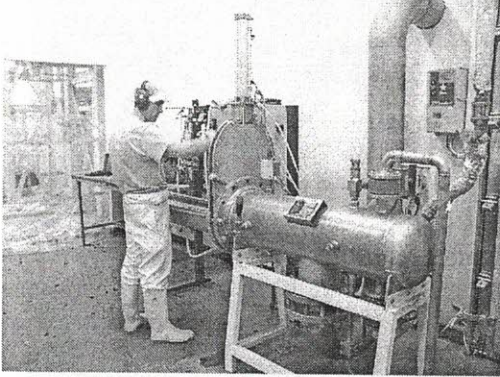
Tubular DIC Reactor



2. DIC-LINear-1 and Manual – DIC LINear – 2

2.1 DIC-LINear-1

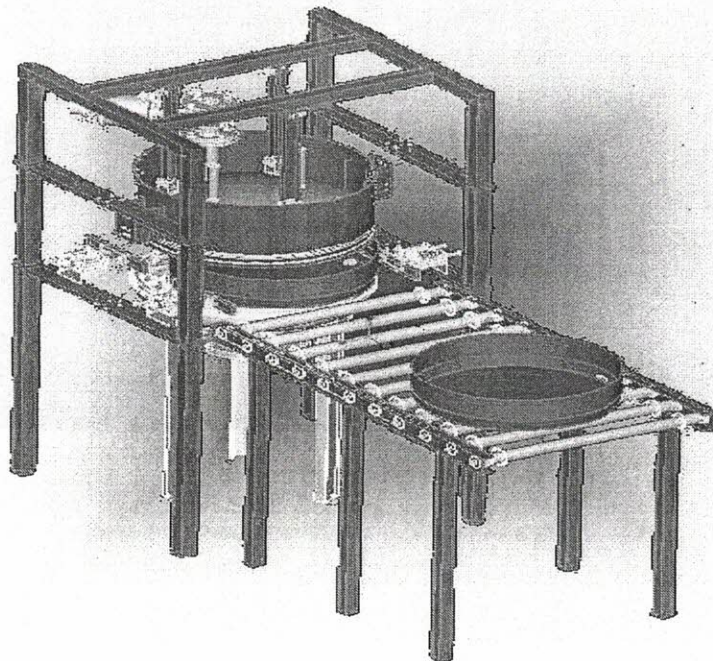
1. On trays machine (0,6m²),
2. Ideal for treatment of in pieces fruits and vegetables
3. Ideal for drying, sterilization, etc.
4. Easy to insert it in a classic treatment line.



2.2 Manual-DIC-LINear-2

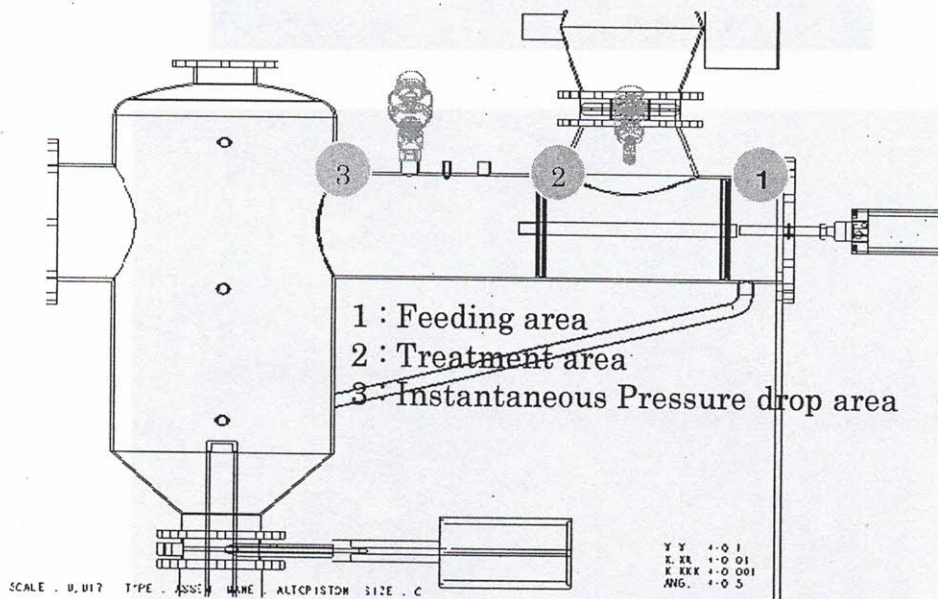
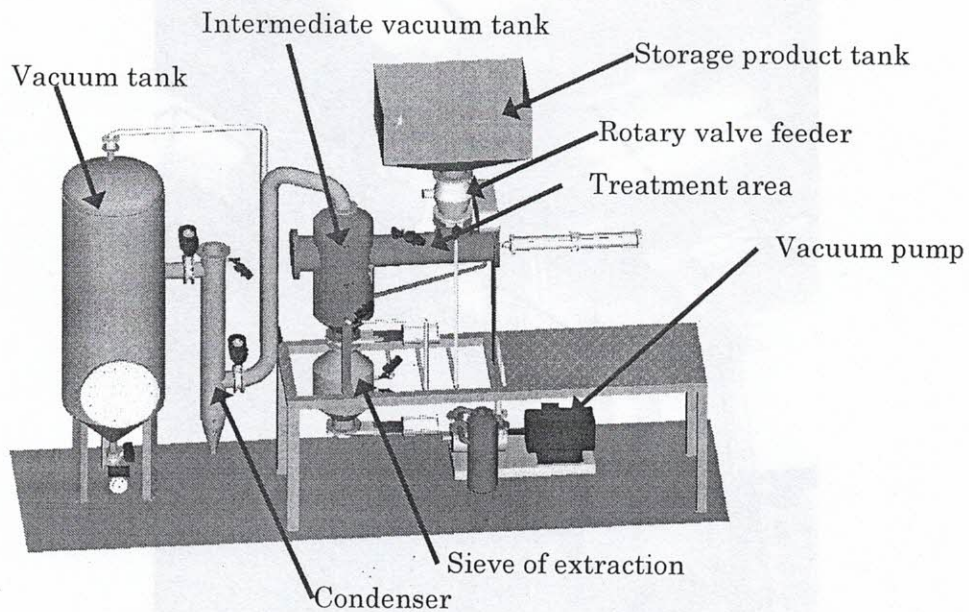
1. On trays machine (2.5 m²),
2. Ideal for treatment of in pieces fruits and vegetables
3. Ideal for drying, sterilization, etc.
4. Easy to insert it in a classic treatment line.
5. Comfortable maintenance

Self – blocking system Manual functioning

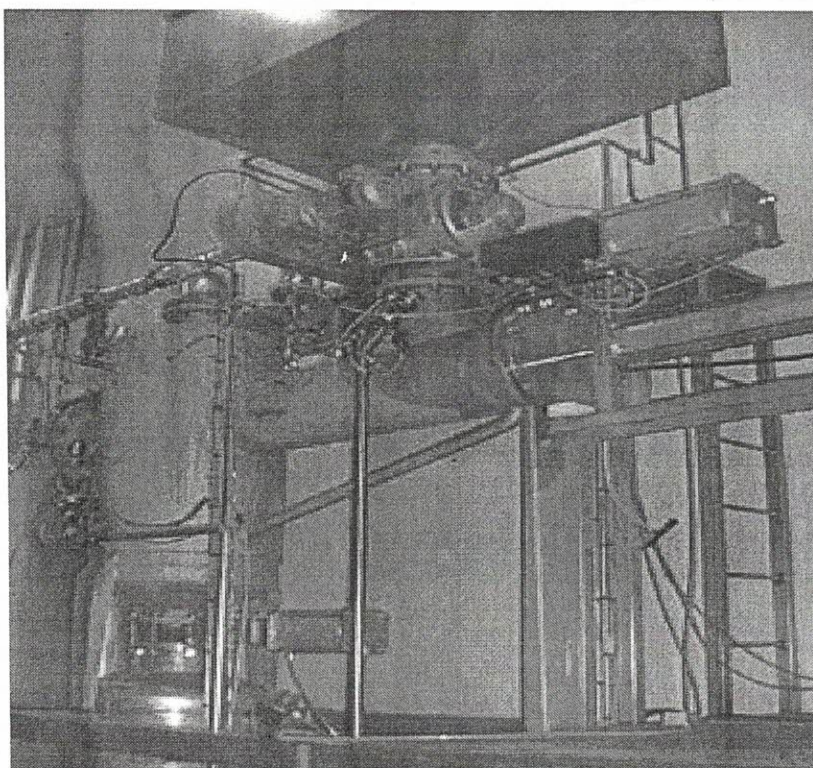
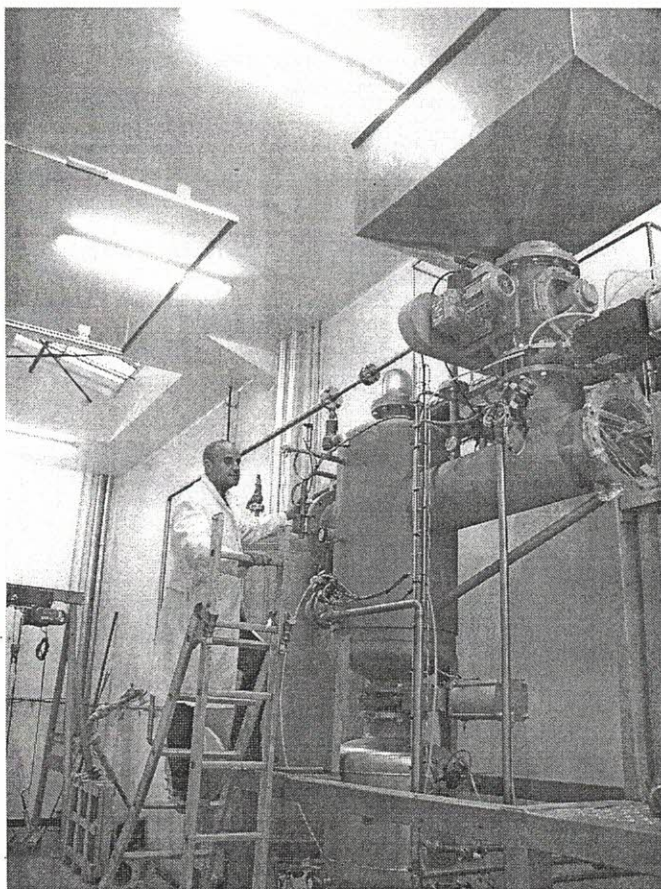


3. DIC-SELF-LUBRICATING

1. In bulk industrial machine
2. Treatment of powder, in pieces products;
3. Ideal for extraction, Sterilization, appertization.

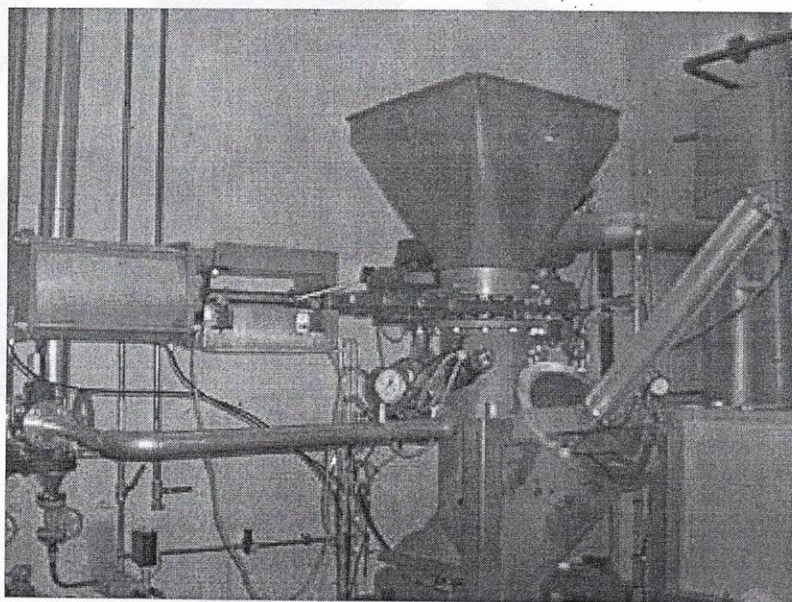
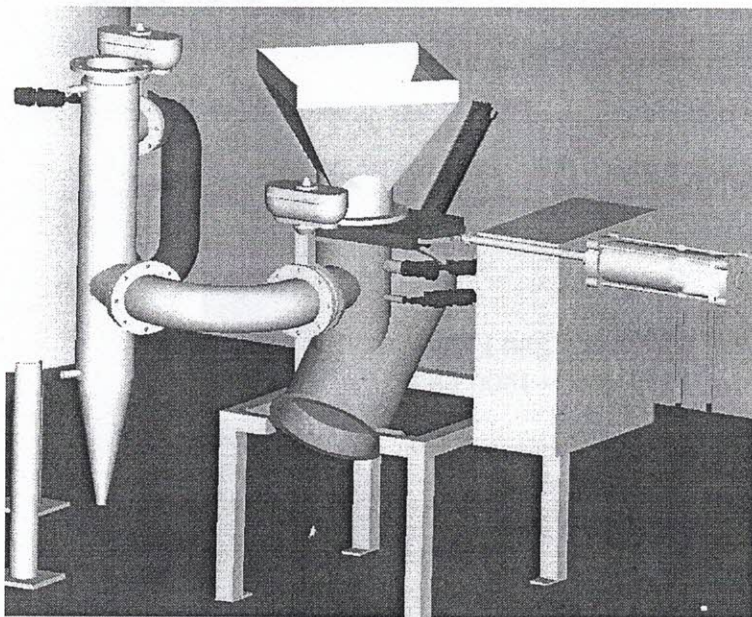


Ikbal working at Self-locked DIC Reactor



4. DIC-DIAGonal

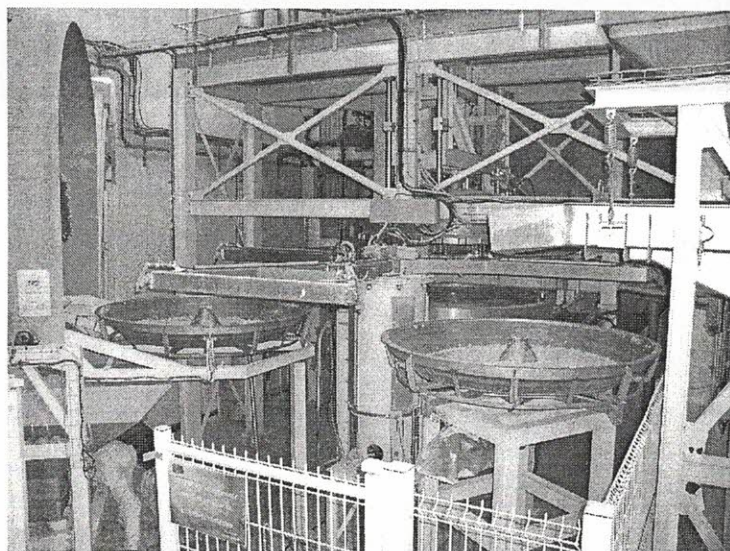
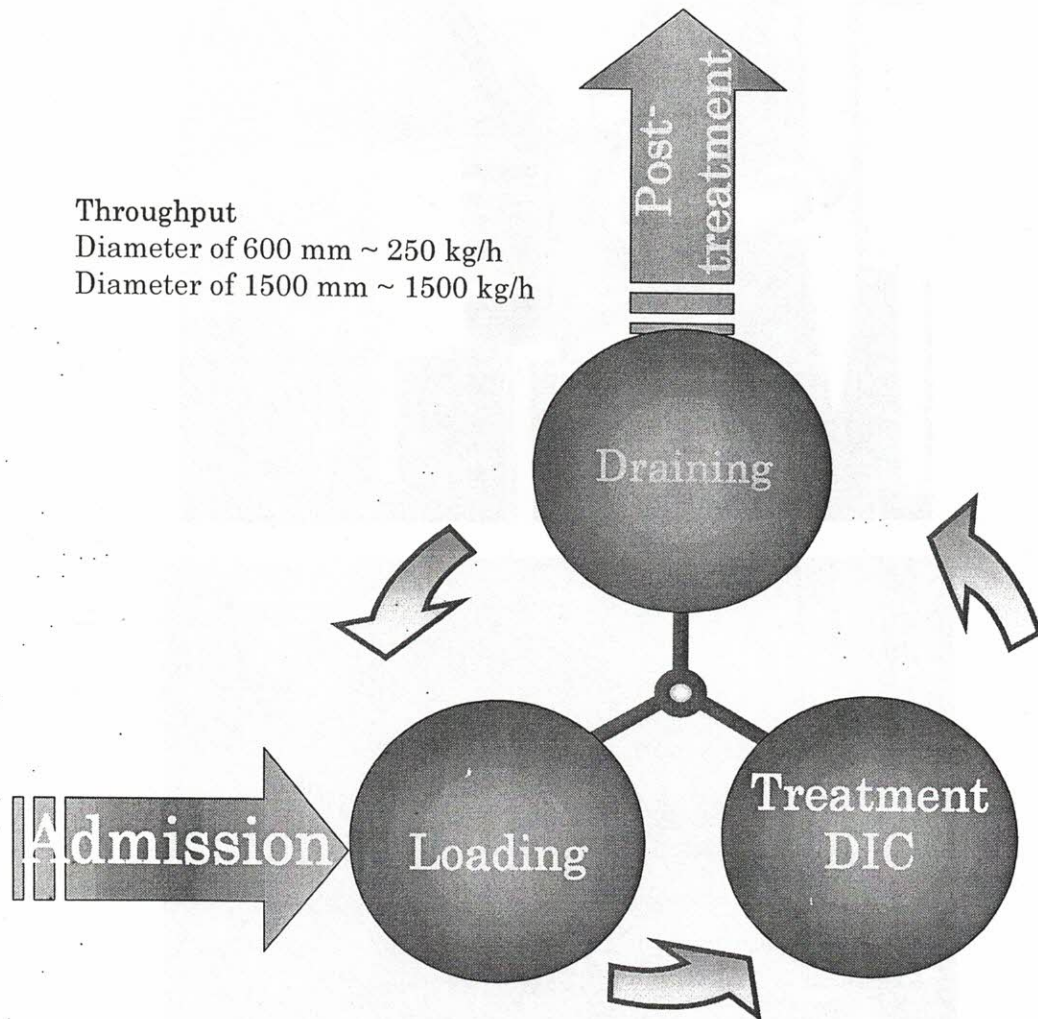
- 50 liters industrial machine;
- Ideal for treatment of specific herbs (tobacco, tea, etc.).



5. STATIC-DIC

- Carousel, flat-bed, NSI System,
- 0,5m² (possibility of 1m² or 2m² versions),
- Adapted to be installed in an "on line hot-air classic drying".

NSI "Static Carrousel" DIC Reactor

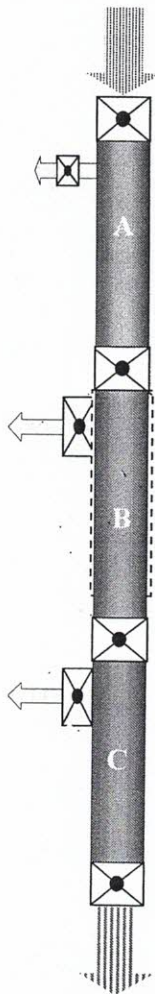


6. DYNAMIC-DIC

- Vertical NSI Industrial DIC System
- Gravitational loading;
- Industrial machine adapted to non fragile products

NSI DIC reactor dynamic" continue "

Dynamic DIC Reactor



Advantages

Continuity of the operation

Easy to use

Low energy consumption

Low working cost

Easy to Change scale

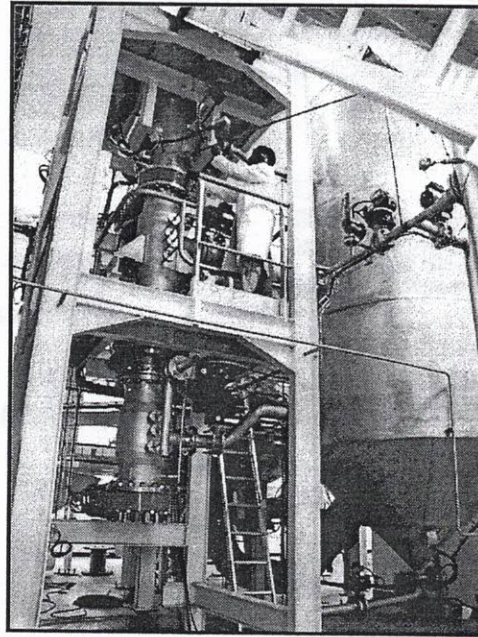
Lower equipment price

Absence of complex mechanical motions

+Weak maintenance

+Weak wear

+Weak footprint .



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www.abcar-dic.com

Impact of DIC® Texture Modification on Drying Kinetics and Final Product Quality

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Abstract

The innovative DIC® technology allows to define a new process named “swell-drying” that leads to very good results in terms of drying kinetics and quality of a large variety of fruits, vegetables, rice, milk, wood, etc. DIC® technology consists of a thermo hydro-mechanical treatment that modifies the texture of the product and preserves its organoleptic characteristics. This paper presents the swell-drying as a combination of hot air drying and DIC treatment. Using classical hot-air techniques, final stage of drying time decreased significantly compared with the time needed to dry untreated products. End product quality is improved leading to good texture, preserving color and flavor, and assuring a perfect decontamination. Vitamin contents are higher than the non treated ones.

Keywords: *swell-drying, dehydration, decontamination, preservation, fruits & vegetables*

Introduction

Drying is one of the oldest and most efficient natural methods for food preservation. In the case of fruits and vegetables, dehydration is generally carried out by hot-air convective drying.

Hot-air dehydration is a slow process for which drying time directly increases with the square of the food piece width (Labuza, 1972). Rehydration of dried products is also a slow process. The taste of rehydrated products is often nowhere near the fresh ones due to the long exposure to high temperature treatment.

Coupled transfer of heat and mass is characteristic to almost all drying processes. Water elimination generates shrinkage and deformation of the final product. The shrinkage induces the increase of thermal conductivity, and thus of internal heat transfer, and the decrease of the pore size and thus of the water diffusivity within the product. Therefore, internal mass transfer becomes the limiting factor that considerably slows down the drying rate and consequently amplifies thermal degradation. A solution for preventing this degradation and for correcting the

deformations could be a texture modification by expanding the product. This step would considerably increase the mass transfer and accelerate the drying rate in its last phase (Louka et al., 2004). Expansion has also a fundamental role in the improvement of the final quality of dried foodstuff.

On the other hand, water elimination does not imply any shrinkage of the product during freeze drying process. But, despite quick rehydration and relatively good quality of final dried products, freeze drying is rarely used in food industry because of expensive equipment and high operation costs. This operation is limited to few cases involving high-value products.

Research on foodstuff product expansion (also called explosion-puffing) was carried out for the first time in 1950 on potatoes (Harrington and Griffiths, 1950). Explosion-puffing process incorporated into a hot-air drying step aimed to yield quick cooking dehydrated fruits and vegetables. The process involves placing the product in a kind of canon and treating it at high temperature and pressure (often steam pressure) followed by a decompression toward atmospheric pressure (Clark, 1986). The explosion-puffing phenomenon is directly related to a complex mechanism of alveolation and depends on the actual operating conditions: initial temperature level, final pressure level (just after pressure dropping) identifying final temperature, and the duration of the decompression. The decompression induces a partial vaporization of the water engendering mechanical constraints within the product which has a visco elastic behavior and undergoes an irreversible adiabatic transformation. The product water content determines the amount of generated steam during decompression. Therefore, a large amount may completely disintegrate the treated product, whereas in the opposite case, the product is not well expanded. Consequently, a partial drying step is a prerequisite for the application of the expansion process. Once expanded, the products are subject to further dehydration in order to lower their final moisture content to less than 5%. This final dehydration step can be carried out in a conventional dryer, by microwaves or using infrared rays (Sugisawa et al., 1985).

Puffing provides products that are less deformed, which can be more quickly rehydrated, with good preservation of flavor and lower operation costs. However, from the original idea of expansion by self-vaporization, the treatment cycle did not really evolve. Systematic parametric studies have rarely been performed and there has been little discussion concerning the behavior of the re-textured matter. Also, the treatment of heat-sensitive food products was very delicate.

Détente Instantanée Contrôlée

During 1990's, a new process of texturing by self-vaporization, Détente Instantanée Contrôlée - DIC (Instantaneous Controlled Pressure-Drop) was developed. This process allows various biological products that are heat-sensitive to be expanded while obtaining very good final quality (shape, texture, color and flavor) (Allaf et al., 1992). It involves a thermo-mechanical treatment of the product followed by an instantaneous Pressure-Drop towards the vacuum. This contributes advantageously on three levels. First, a net increase in temperature difference, where the final equilibrium temperature is close to the saturation temperature (30°C at 0.05 bar) and the amount of generated steam is therefore sufficiently great at a lower treatment temperature (150°C toward 30°C instead of 220°C toward 100°C). Second, the reduction in the final temperature leads to a reduction in heat-induced deterioration of sensitive products. Third, low final temperature allows the product to easily

maintain its new expanded structure. The amount of steam generated by self-vaporization increases as the final equilibrium temperature is lower, and cooling is more intense as the final equilibrium pressure is lower (Louka and Allaf, 2002). DIC texturing of sensitive food products involves a short treatment of around 15 s at a temperature below 150 °C, followed by an abrupt (Instantaneous) Pressure Drop towards a vacuum of 0.1 bar. The re-texturing carried out in these relatively mild conditions, followed by a very rapid and intense cooling, results in a product that maintains a highly satisfactory color and shape after the final drying.

The reactor, based on the above fundamental approach, consists of the following three main components: 1) the processing vessel where the samples are disposed, equipped with thermocouples and a pressure detector. All these elements are linked to a data acquisition system. Within the processing vessel, a controlled pressure can be obtained from a primary vacuum. 2) the vacuum system, which consists of a vacuum tank 60 times greater than the processing vessel and an airlock system that enable one to evacuate the condensed water in the tank. The processing vessel and the vacuum tank are connected through a pneumatic valve that can be operated instantaneously. 3) the decompression system. Figure 1 shows a photo of a tubular reactor, with manual feeding that is used for testing and treatment of limited amounts of products.

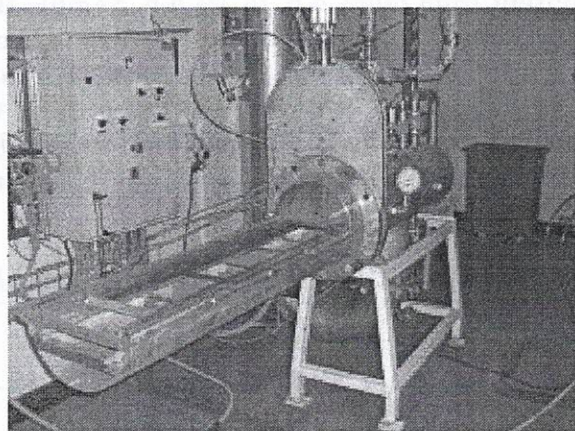


Fig. 1 DIC tubular reactor

Numerous parameters involved in DIC technology have special importance concerning the quality of final products. There are two parameter categories that influence the process: inherent and operating parameters. The inherent parameters, such as initial steam pressure, vacuum tank pressure and duration of the pressure-drop, contribute to the definition of the DIC technology itself. These parameters have to be set up for all products at optimal levels that depend in particular on the apparatus capacity. The operating parameters depend on both the steam treatment and the product itself and include: saturation pressure of the treatment steam (which also determines the treatment temperature), treatment time, initial water content of the product and thickness of the product pieces.

Specific food products that generally fail to give a desirable final quality after DIC expansion belong in particular to the following three cases: a) Very heat-sensitive products. Although treated under relatively mild conditions (temperature below 150 °C or a short time), some fragile products are likely to undergo certain degree of thermal degradation. b) Products with a very low hardening temperature. Although

the final temperature after dropping pressure is about 30 °C, certain products do not reach their hardening level, are not able to maintain their own new expanded structure, shrinkage takes place and will then have a shriveled surface after final drying. c) Products treated in thick layer. After treatment under preset operating conditions, the products are quite well expanded at the surface of the layer while not expanded far from the periphery, with no improvement in volume recovery. A prolonged treatment may expand the whole sample but the outer layers will lose their color. Some modifications of the standard DIC treatment cycle were made to overcome the above problems (Louka and Allaf, 2004). The establishment of an initial vacuum phase prior to the steam treatment, a treatment by step-wise increases in temperature and an atmospheric air injection as a last phase, enable to obtain good results for product pieces in thick layer, very heat-sensitive and with a low hardening temperature.

Drying Kinetics

DIC treatment is followed by a final drying in order to bring the product to the water content that is required for storage. The impact of DIC technology on final drying kinetics was studied by Louka and Allaf (2002) for three samples of potato pieces: A, B and C. Sample A was dried only by conventional hot-air drying and needed 600 min to decrease the water content from 80.5% d.b. to 4% d.b. Sample B was initially dried, in the same conditions as Sample A, up to 25% d.b. for 220, directly followed by DIC processing and then, finally dried for other 220 min to reach 4% d.b. It was considered that change in water content during DIC processing was negligible. Last sample was similarly treated to sample B but including an equilibration step before the DIC step; the final drying time was in this case only 100 min. The values of the drying kinetics for the three samples are given in Table 1.

Table 1 Drying kinetics for three potatoes samples

Water content [% d.b.]	from 80.5 to 25	from 25 to 4
A - without DIC	220 min	380 min
B - with DIC	220 min	220 min
C - DIC + equilib.	220 min	100 min

The study was done on two levels: first one consisted in evaluation the inherent effect of expansion by DIC (comparing samples A with B), and the second one concerned the effect of the repartition of alveolation in the expanded product, as a result of the distribution form of residual water in the product (comparing samples B with C). The reduction in final drying time for samples B and C compared to A is a direct consequence of the expansion by DIC processing. The porosity acquired by expansion certainly improves the mass transfer and allows water trapped within the product to escape more easily than in normal hot-air drying. Final drying time of sample C was significantly decreased compared to B due to the homogeneous alveolation in the product generated by the equilibration step before expansion.

Final Product Quality

The quality of the expanded products can be expressed in terms of three response parameters: expansion ratio, color and degree of cooking. These parameters were systematically studied as a function of saturated steam pressure, treatment time and water content of the product just before DIC treatment. The combination of time and temperature determines the intensity of the treatment.

Pressure is the parameter that establishes the level of the decompression for a given final pressure and, in particular, the treatment temperature using saturated steam. For vegetables, pressure seems to be the parameter that exerts the most significant effect on the expansion ratio. Pressure defines the treatment temperature and the extent of the fall in temperature that determines the amount of steam generated by self-vaporization and thus the intensity of the mechanical constraints which provoke the expansion of the product's structure. In the general pattern evolution of the expansion ratios as a function of pressure, three phases can be distinguished. During the first phase, at low pressure, corresponding to very small expansion ratios, the amount of steam generated is not sufficient to give rise to the intense mechanical constraints capable of provoking the expansion of the product. During the second one, characterized by a rapid increase in the expansion ratio, the mechanical forces induced by the steam become sufficiently strong to break through the resistance threshold of the matter. The expansion ratio variation is proportional to the amount of steam generated and varies almost linearly. During the third phase, there is an almost complete stabilization of the expansion ratio. The amount of steam is so great that it enlarges the existing pores considerably and creates fissures in the product, which reaches the limits of its elasticity. A part of the steam escapes out of the product and consequently stabilizes the level of the expansion ratio. Most of the expanded products have volumes ranging from 2 to 5 times the volumes obtained after drying by hot air only. For carrots, onions, broccolis and tomatoes, the expansion ratio reaches stabilization at around 5 bar and for potatoes at a pressure of 9 bars due to the very dense structure of the potato after hot air drying in comparison with the other vegetables (Louka et al., 2004).

The variation in expansion ratio vs time has four distinct phases. First phase corresponds to short treatments during which the product expands little and reaches thermal equilibrium. The mechanical constraints created by the steam generated during the Pressure Drop are not sufficient to swell the product, which remains still hard and plastic. During the second phase, the product starts to acquire a viscoelasticity that allow it to be expanded. The expansion ratio increases rapidly in an almost linear manner. Third phase corresponds to a period of optimal expansion and in the last phase the expansion ratio begins to fall down and two phenomena could occur: the product may become too elastic and so the volume shrinks after expansion, or the structure of the product may collapse due to a prolonged treatment at high temperature. An extended treatment can lead to a total collapse of the structure or even a liquefaction of the product.

The variation in expansion ratio as a function of water content has also four distinct phases. First one consists in an extremely fast increase in the expansion ratio. The presence of water in the product before treatment is indispensable for the production of steam: the higher the initial water content, the greater is the quantity of water that could be evaporated during the abrupt Pressure Drop. The second phase is very short and stabilizes the expansion ratio followed by a sharp drop phase. During the last one, corresponding to very high water content, a large amount of steam may be

generated, which could partially or totally disintegrate of the product.

Thickness seems to play a very important role in terms of expansion ratio. It has two variation phases: first in which it increases and second in which it decreases, with a maximum at around 3 mm thickness. In the first phase, escape of the generated steam seems to be more and more difficult with the increase of the piece thickness and the expansion is therefore greater. The decrease of the expansion ratio during second phase is due to a greater resistance of the matter to deformation.

Color can be expressed on a scale from 0 to 4, where 4 corresponds to the color of the control product. Modification in color only occurs at the end of the second expansion ratio phase as a function of pressure and becomes more obvious at the beginning of the last phase, being different from one product to another. Naturally, a long treatment at high temperature can lead to a change in the color of the product. The presence of water in the product protects against thermal alterations. Low water content ($< 5\%$) can lead to a drastic deformation, which can seriously discolor the product. A water content of around 15% is indispensable to avoid a major modification of the color of the product.

Cooking rate is considered to be a quality criterion in the preparation of soups and ready-made meals for which rehydration is called "instantaneous". An evaluation of the cooked product can be done by people trained in sensorial analyses. The dried product is dipped in a bowl with boiling water and left covered for one minute. After tasting, it is evaluated as: uncooked, well cooked or overcooked. For the last one, the products have a mushy structure due to severe heat degradation and their structure is weakened by the abrupt pressure drop and the rupture of their cells (Debs-Louka et al., 1996). These products can be very quickly rehydrated but water is not efficiently retained by the matrix, which corresponds to a rather spongy look. With the exception of very low water content ($< 5\%$) when the products are often caramelized, the treatment time has no major influence on the product degree of cooking.

Some examples of fruits and vegetables, i.e. onions, tomatoes, strawberries, apples, kiwis, red peppers, bananas and carrots, treated by DIC technology are presented in Figure 2. Figures 3 and 4 give detail image of swell-dried kiwi and red pepper.



Fig. 2 Example of swell-dried products

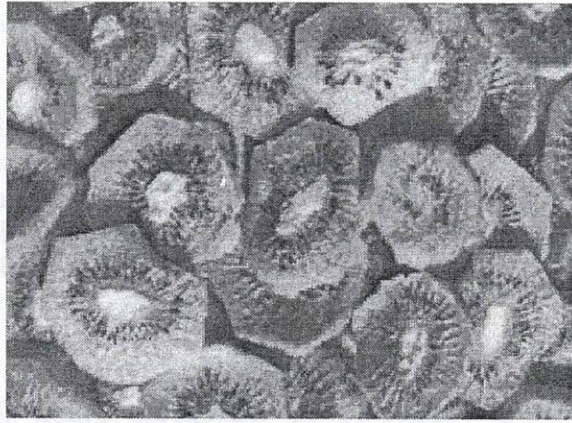


Fig. 3 Swell-dried kiwis



Fig. 4 Swell-dried red peppers

Conclusions

Internal resistance limits the dehydration rate of capillary porous materials especially during the last drying stage. Most of the products reveal an important degree of shrinkage that contributes to the decrease of effective moisture diffusivity with drying time. Expanding partially dried foods (water content around 20% -dry basis) is a valuable alternative both for increasing the drying rate and improving final product quality.

Drying kinetics shows the beneficial effect of DIC incorporation into the hot-air drying process. The introduction of an equilibration step during which the water of the product is homogenized after initial drying, significantly reduces the duration of final drying step.

General patterns were discussed for the variation in the expansion ratio as a function of saturated steam pressure, exposure time to high pressure and temperature, initial water content of the product and thickness of the pieces. DIC technology can be used to control the quality of the final product and also to provide dried vegetables with a cooking time of one minute compared with approximately 15 min immersion in boiling water needed for vegetables classically dried with hot-air to cook them properly. The use of atmospheric air flow injected just after decompression may intensify cooling effect; it may allow low hardening temperature products to avoid final shrinking and fixes them in an expanded state. Creation of a vacuum in the

processing vessel before the steam injection enables DIC to be successfully used with thick pieces of product (approx. 15 cm).

The overall impact of DIC technology results in saving time and drying costs together with an improvement in finished product quality. It was successfully industrialized for different types of vegetables such as tomatoes, red and green peppers, green beans, peas, onions, leaks, garlic, cabbage, cauliflower, broccoli, carrots, potatoes, turnips, parsnip as well as many fruits such as strawberries, apples, kiwis, bananas.

Acknowledgements

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Thermodynamics of Instantaneous Processes

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Abstract

The classic thermodynamics is incapable to foresee some phenomena when the transformations take place in an abrupt way. Numerous experimental observations prove the existence of a bifurcation according to the length of the transformations. A specific theoretical analysis to the phenomena of instantaneity (asymptotic approach) has been studied already and proposed by K. ALLAF in 2002. It gives a new approach to numerous operations with especially large applications. In the present work, we are about using this analysis to explain and to prove its relevance in the case of some phenomena thermodynamic such as: the DDS, the under vacuum spray drying,...

Introduction

The classic thermodynamics cannot explain the phenomena intervening when processes are instantaneous. In many cases studied and developed in the Laboratory Mastering of Agro-Industrial Technologies (LMTAI), the phenomena of instantaneous autovaporisation depend strongly on the instantaneous nature of the operation. Thus, the kinetics of drying in the case of the Dehydration by Successive Pressure - Drops (DDS) is higher when we carry out abrupt pressure - drops. In the pulverization under vacuum, the shorter the length (more "instantaneous"), the more intense the operation of autovaporisation

Dehydration by Successive Pressure - Drops (DDS)

During the Dehydration by Successive Pressure - Drops (DDS), the products follow a succession of cycles formed of two main stages:

- ✓ A setting to high air pressure and waiting of a certain period time D_{ph}
- ✓ An abrupt release of pressure ($\sim 1/100$ s) toward vacuum and waiting of a certain period time D_{pv}

The product water is partially eliminated by autovaporisation mainly when pressure is dropping.

Some tests have been achieved while modifying the time of the drop of pressure. We notice that the quantity of water removed when the pressure - drops are abrupt ($\sim 1/100$ s) is extensively superior to the one gotten by slow pressure - drops (> 1 s) both ones toward vacuum.

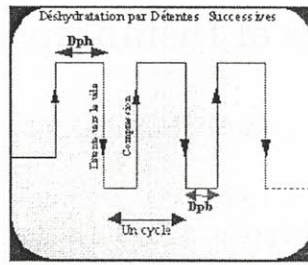


Figure 1 : The dehydration by successive pressure - drops

Vacuum Spray – Drying VSD

Works carried out by M. DELGADO-ROSAS (2002) within the LMTAI, the quantity of water removed (evaporated) during this spraying is much higher when we collect the sprayed product close of the buzzard.

Experimentation

To understand better these phenomena, we achieved some experiences by measuring temperature of a droplet of water suspended to a very fast answer time thermocouple.

This droplet of water undergoes an initial air pressure up to 2 bars, followed by a drop of pressure toward vacuum (~ 10 mbars).

We achieved two types of pressure drops toward vacuum thus:

- ✓ an instantaneous one ($-\Delta P/\Delta t \sim 8 \text{ bars.s}^{-1}$)
- ✓ a slow détente toward the emptiness ($-\Delta P/\Delta t \sim 0.5 \text{ bars.s}^{-1}$)

Figure 2 and Figure 3 show the gotten results.

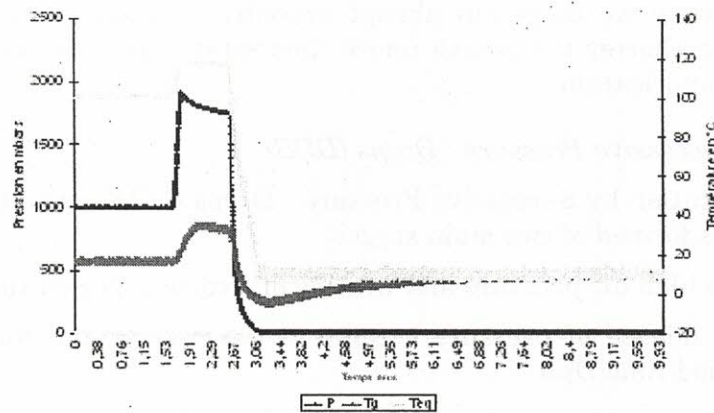


Figure 2 : Evolution of temperature of droplet water ($< 2 \text{ mm}$) and total pressure vs time by instantaneous Dropping air pressure ($-\Delta P/\Delta t \sim 8 \text{ bars/s}$)

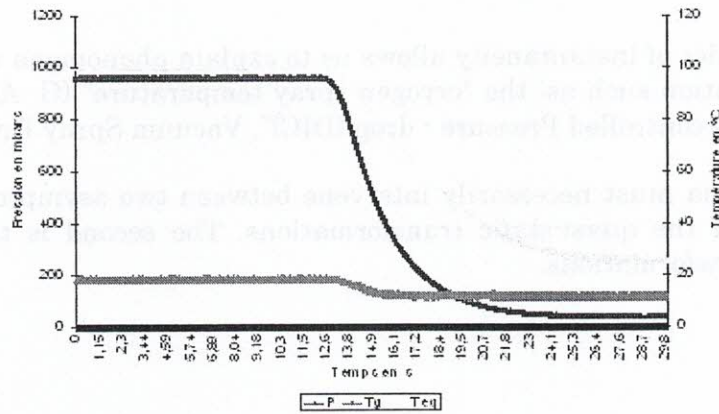


Figure 3 : Evolution of temperature of droplet water (< 2 mm) and total pressure vs time by low Dropping air pressure ($-\Delta P/\Delta t \sim 0,5$ bars/s)

We notice during the instantaneous releasing pressure toward vacuum (from 1,7 b towards 11 mbars), that the droplet temperature reaches -5°C before getting back to the equilibrium temperature of $8,5^{\circ}\text{C}$.

During a slow releasing of pressure (35 mbars, the initial pressure being of 1.b) the temperature of the drop remains almost constant.

Interpretation

All thermodynamic transformations aim to reach total thermodynamic balance; it implies a generation of total entropy ($(\Delta S_{\text{system}} + \Delta S_{\text{ext}}) > 0$).

Is the Joule decompression, the irreversible adiabatic transformation is characterized by the generation of a quantity of total entropy ($\Delta S_{\text{total}} > 0$ positive), in spite of an adiabatic nature of the transformation $Q=0$.

K. ALLAF gives out the hypothesis according to which the flux of total entropy ΔS_{total} cannot be infinite. Thus, the variation of the generated total entropy in relation to the time $\Delta S_{\text{total}}/\Delta t$ must be a finished quantity. In the instantaneous phenomena, as Δt does stretch towards zero ($\Delta t \rightarrow 0$), is it obvious that the quantity of generated total entropy stretches toward 0 ($\Delta S_{\text{total}} \rightarrow 0$).

First of all, this "law" means that instantaneous transformations can only take place in complex systems, with several thermodynamic parameters. For one parameter system (as temperature), the evolution can be only evolutionary versus time generating a positive total entropy.

Thus, during an abrupt pressure - drop toward vacuum (Figure 2: $-\Delta P/\Delta t \sim 8\text{bars.s}^{-1}$), the "instantaneity" of the operation immediately induces an evolution of the vapour pressure (phase balance), whereas the temperature of the droplet evolves in an opposite sense to the one needed by the thermodynamic balance; the temperature may reach a value extensively lower to the one of the balance. The partial entropy generated by this fall of temperature does oppose to the one generated by the variation of the vapour pressure so that the generated total entropy stretches toward 0.

Discussion

The thermodynamics of instantaneity allows us to explain phenomena undergoing an abrupt transformation such as: the "cryogen spray temperature" (G. AGUILAR), the "the instantaneous controlled Pressure - drop (DIC)", Vacuum Spray Drying (VSD),...

Physical phenomena must necessarily intervene between two asymptotic limits: the first is the one of the quasi-static transformations. The second is the one of the instantaneous transformations.

DIC in the operation of Steaming & Parboiling of rice

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I. Processes

The DIC technology may intervene in two main processes:

1. A post-harvesting steaming treatment of fresh paddy rice in order to get high quality – firm “steamed” rice (integral or white forms), reducing drying time (as a 2 hour swell - drying instead of 8 hours, normally required), reducing the broken rate (less than 3 % instead of more than 18%...), mastering the cooking time (7 minutes up to 15 minutes for white rice)...and leading to a white color...
2. A parboiling treatment intervening after a special soaking phase of paddy rice; it concerns a very short thermal treatment (30 seconds) in order to get high quality – firm “parboiled” rice (integral or white forms), with a short drying time (as a 2 hour swell - drying instead of 8 hours, normally required), reducing the broken rate (less than 3 % instead of more than 12%...), mastering the cooking time (7 minutes up to 15 minutes for white rice)... and leading to a light color...

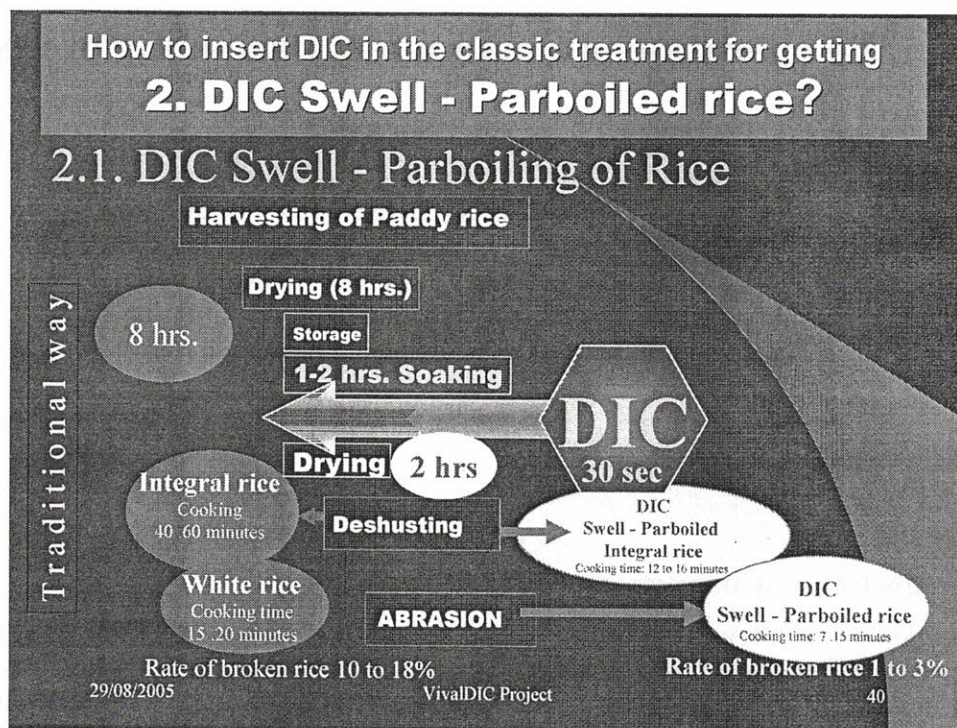
All the tests carried out proved the possibility of DIC treatment to lead to a very high quality finished product on the following points:

- Improvement of textural behavior
- Controlled reduction of the cooking time
- High improvement of the yield
- Reduction of energy consumption cost

European experts (from EU) have estimated that the DIC technology has a more than six year advance compared with other similar European or American technologies.

II. Steaming fresh paddy rice by Instantaneous Controlled Pressure Drop DIC

The objective of parboiling rice by Instantaneous Controlled Pressure Drop DIC is to provoke a very specific “Swell – drying” process; it improves the drying kinetics and the final product quality. By DIC hydro-mechanical-thermal treatment, we can modify physical, chemical and sensorial characteristics of fresh harvested paddy rice. Such modifications are advantageous in practical, functional and economical levels.

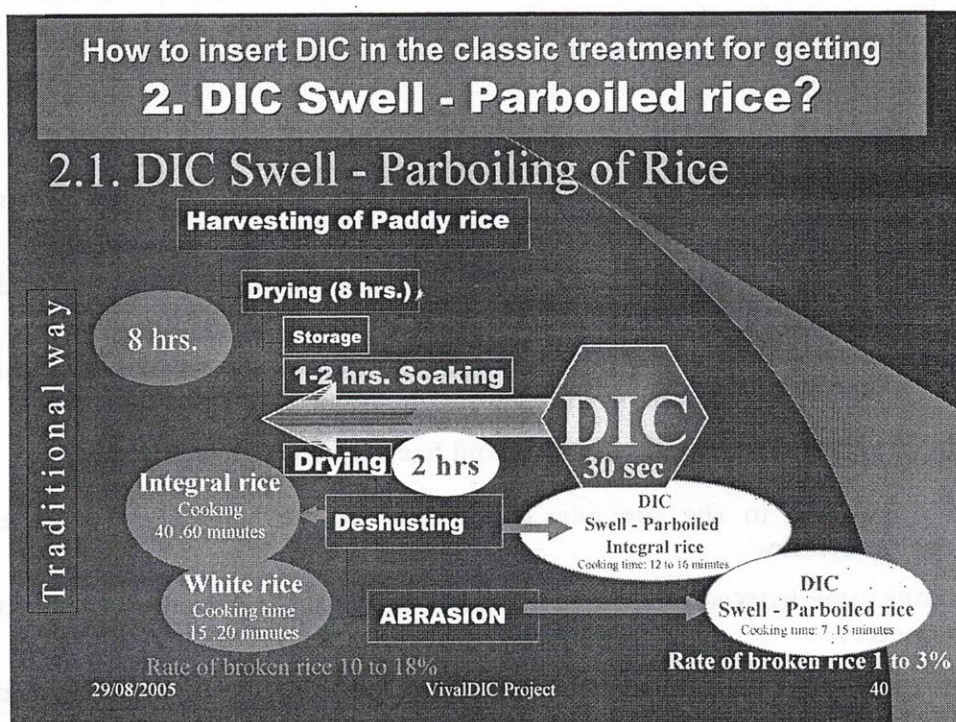
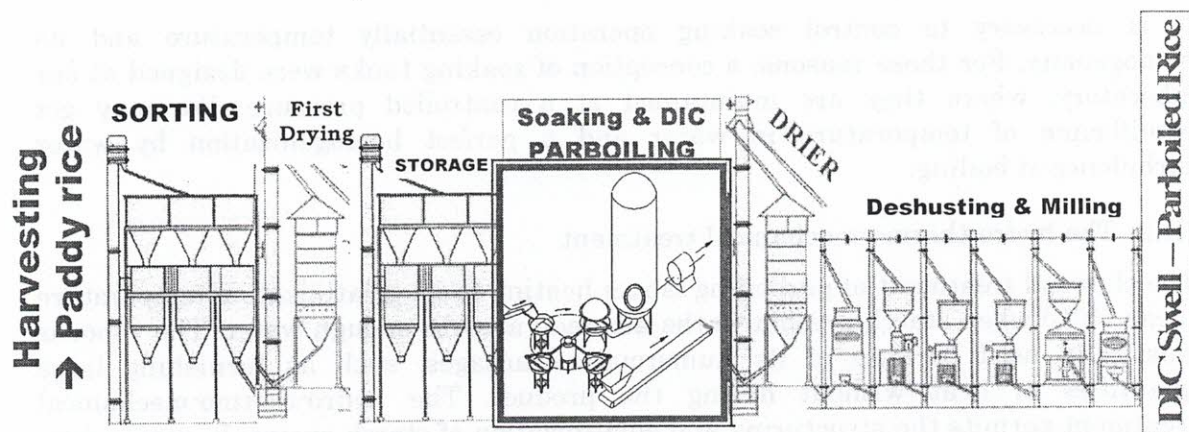


By using the Instantaneous Controlled Pressure - Drop DIC steaming, the high temperature treatment allows the just harvested fresh rice treated during some 30 seconds, to get gelatinized starch and the pressure drop toward vacuum permits some controlled modifications of the structure. The kinetics of drying is improved and the broken rate of final product is lower than 3%. The final "DIC Swell - Steamed rice" is generally "quick cooked rice"...

III. The different steps in parboiling by Instantaneous Controlled Pressure Drop

The objective of classic parboiling of rice is the production of physical, chemical and sensorial modifications that are advantageous in practical, economical and nutritional levels. These modifications result classically by hydro-thermal treatment.

In the case of Instantaneous Controlled Pressure Drop DIC parboiling, the principal is identical at the level of thermal aspects, but the use of pressure drop toward vacuum permit high modification of the treatment and considerable reduction of time of thermal treatment. At the same time resulting in a better structuring of the product.



III.1 Soaking

Soaking is necessary for furnishing starch with sufficient quantity of water for its complete gelatinization. This humidity is near 30 % (wet mass). Several studies realized in our laboratory on this subject, showed that hydration of rice should be realized at mastered temperature between 45°C and 65°C. This temperature is determined in order to get ulterior gelatinization in short time.

A study realized on the use of vacuum on rice before addition of soaking water showed the possibility of the reduction of soaking period (1hr instead of 4 hr). In fact the vacuum eliminates large part of air situated between the grain and husk and so optimizing water and heat diffusion. This soaking step is essential for good parboiling by DIC.

It is necessary to control soaking operation essentially temperature and its homogeneity. For these reasons, a conception of soaking tanks were designed at our laboratory, where they are maintained at a controlled pressure. We may get equilibrium of temperature in water and a perfect homogenization by water turbulence at boiling.

III.2 The hydro-thermo-mechanical treatment

The classical treatment of parboiling is rice heating to its gelatinization temperature (near 70°C) when starch present in the albumen absorbs enough water. The vapor is classically used because of its numerous advantages, such as furnishing large quantities of heat without drying the product. The hydro-thermo-mechanical treatment permits the structuring and gelatinization of starch grains. In comparison with the classical parboiling, the heat treatment will permit the gelatinization of already swollen starch grain. Then the instantaneous pressure drop toward vacuum will create an autovaporisation of water located in the interior of the grain creating mechanical constrained and so structuring of the grain (formation of micro-porosity). This autovaporisation of water has also the consequence of decreasing 1 to 2 % the grain humidity.

The DIC is composed of the following steps:

1. Filling the product into the treating vessel and applying initial vacuum so as to facilitate the diffusion of steam in close contact with the product
2. Maintaining an absolute saturated steam pressure (between 4 and 8 bar) during 30 to 60 seconds
3. Instantaneously dropping the pressure toward vacuum by connecting treatment vessel with vacuum tank (the final pressure should be < to 50 mbar)
4. Opening air shower to cold the product and back to atmospheric pressure

With this treatment, in the previous conditions, we get parboiled rice with the following characteristics:

- ✓ Cooking time between 7 and 15 minutes, controllable by modifying treatment parameters
- ✓ Full grain rate more than 72% (instead of 67% for non-parboiled rice product)
- ✓ Complete and homogeneous gelatinization (Not totally gelatinized grain < 3%)
- ✓ High organoleptics quality of product
- ✓ A firm texture in mouth
- ✓ Brighter than a traditional parboiled rice

The short time of steam treatment (less than one minute instead of 40 minutes in the classical treatment) induces an important decrease in energy consumption.

III.3 Drying

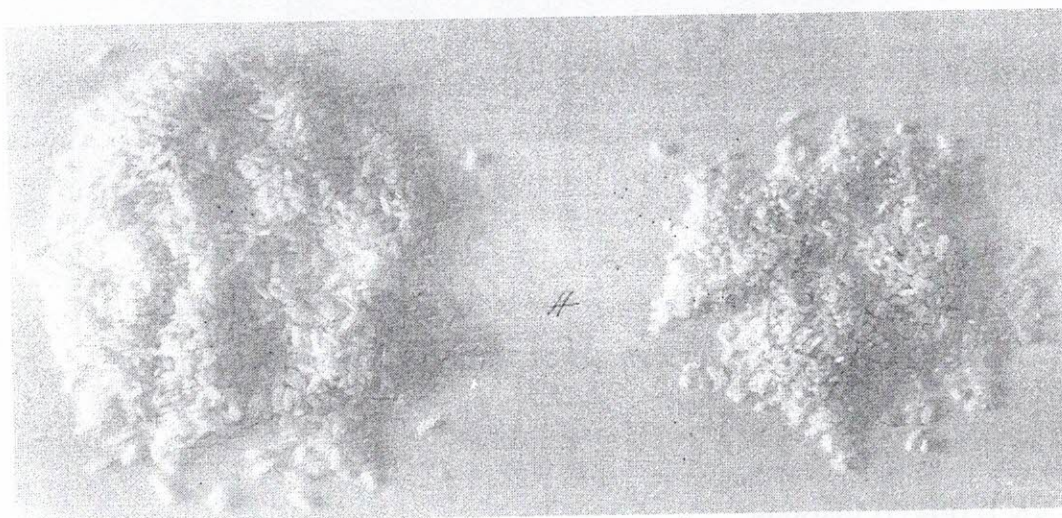
Drying permits to decrease the humidity content towards an optimum level for storing and milling. This operation is highly shorter than the one classically used (2 hrs. instead of 8 hrs.). Classically drying of rice is done in two steps:

1. First at the end of parboiling the humidity change from 28-30% to a final content of 18-20%, at this level of humidity the rice is not affected by the high temperature used.
2. Secondly, the humidity changes from 18-20% until 15-16%. At this step low temperature should be used because at this zone of humidity the product can lose the obtained qualities by DIC parboiling.

The drying step has an essential role that of preservation of qualities obtained by the parboiling step. So it is important not to neglect this step and to optimize it.

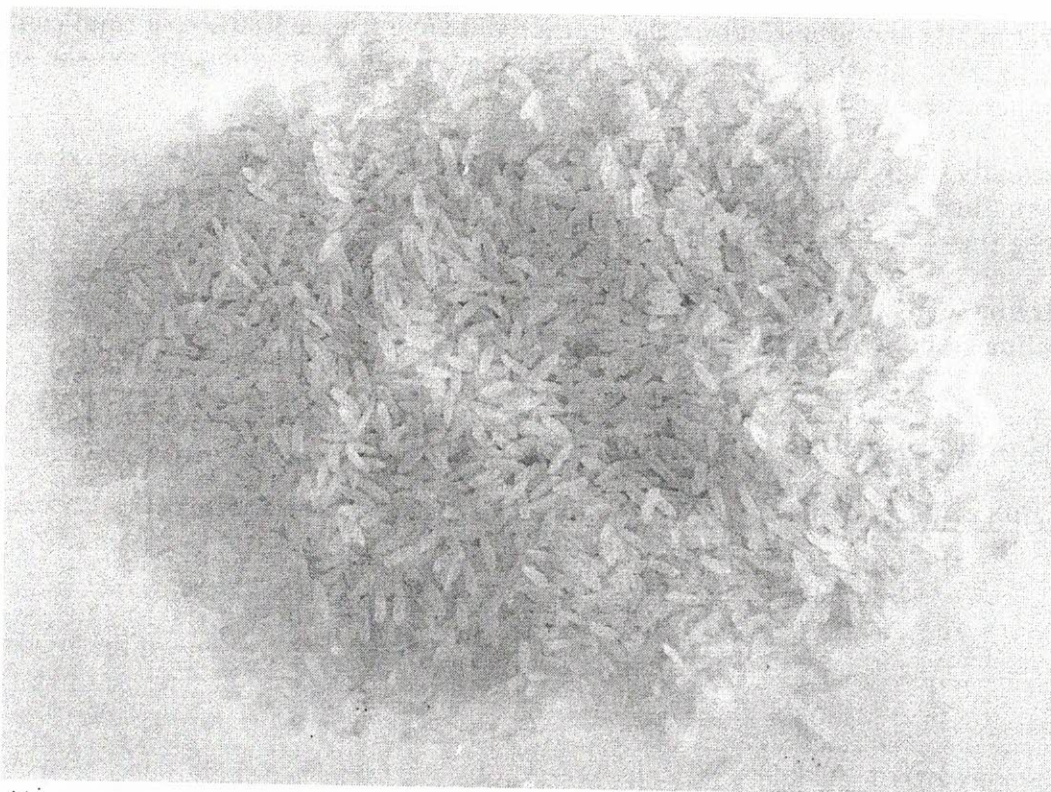
IV. Some examples of products

IV.1 CP02 variety, Chau Phu 2 (Aromatic variety Giang, VIETNAM)



Initial rate of broken rice: 17.2%

Cooking time of initial rice: 15 - 17 minutes

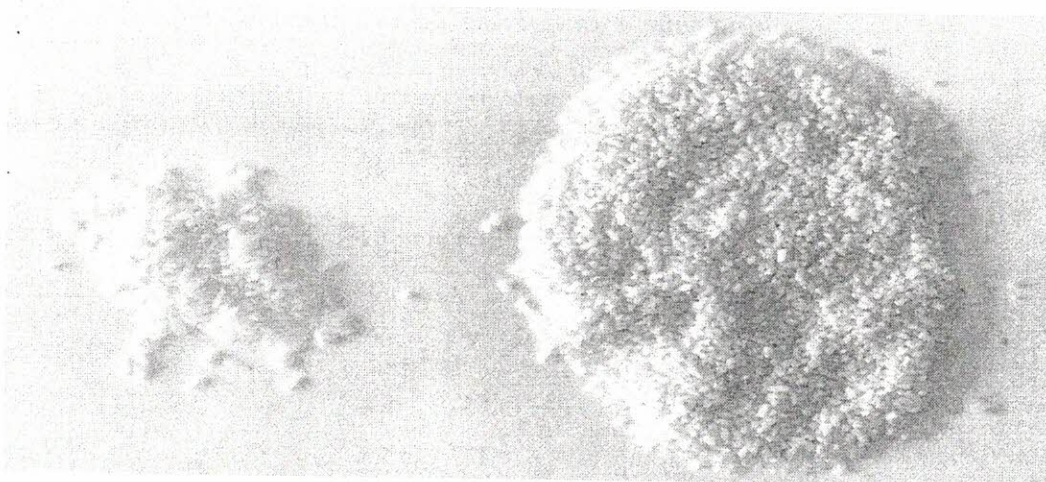


Final rate of broken rice (after DIC): 1 - 3 %

Cooking time of treated rice (after DIC): 7 - 9 minutes

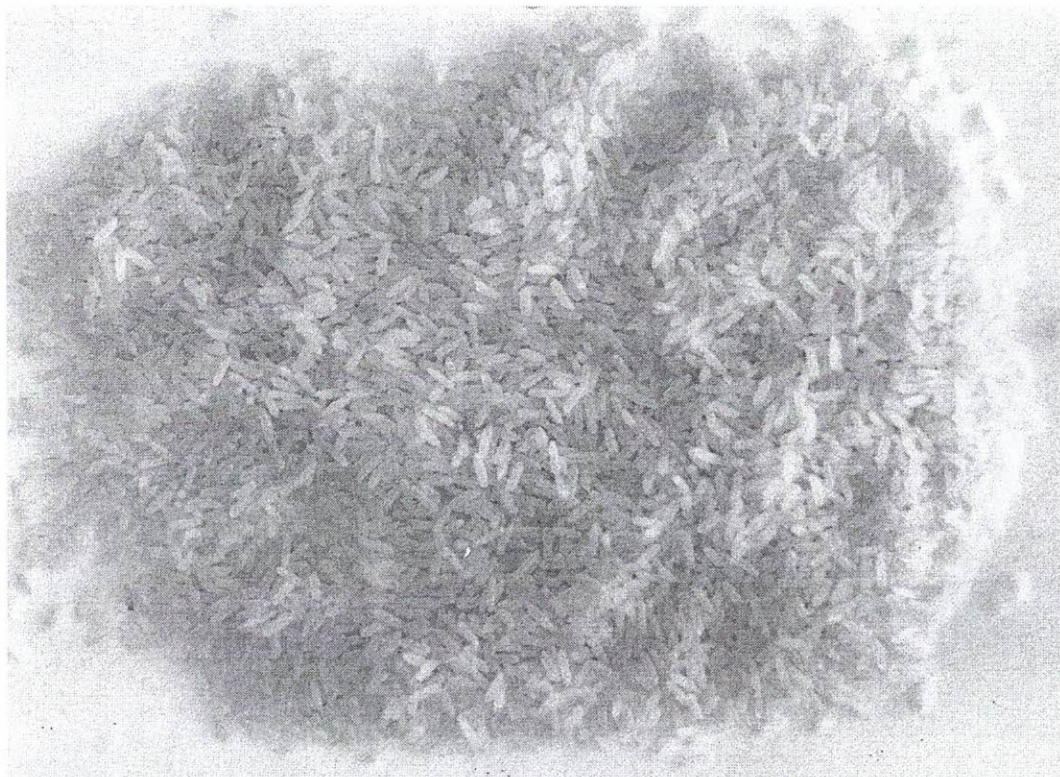
Aromatic value: Perfect preservation of aromatic content

IV.2. VN D (PHTI) Vietnam



Initial rate of broken rice: 49.4%

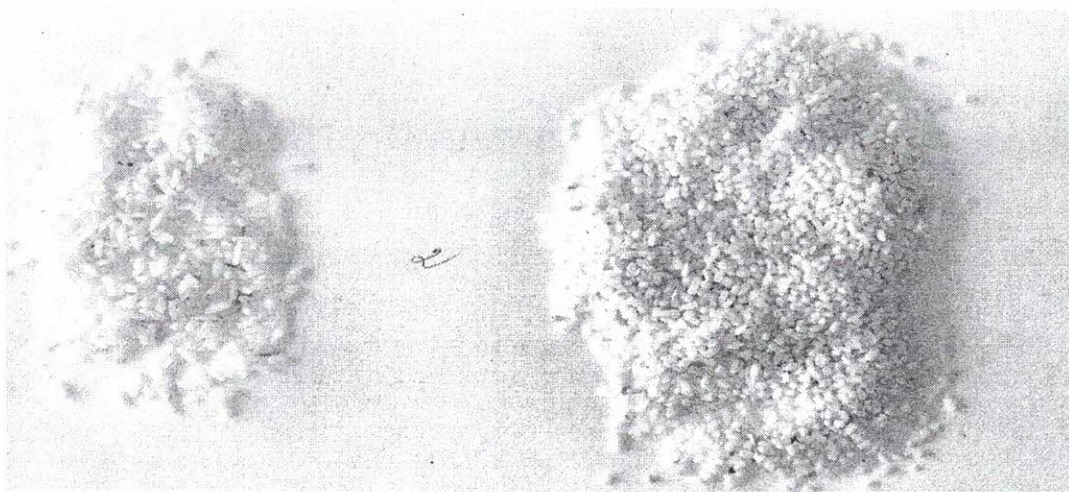
Cooking time of initial rice: 15 - 17 minutes



Final rate of broken rice (after DIC): 4 – 6 %

Cooking time of treated rice (after DIC): 7 - 9 minutes

IV.3 Variety" Long One"



Chalkiness rate of initial product: 25%

Initial rate of broken rice: 44%



Final rate of broken rice (after DIC): 4 - 6 %

Cooking time of treated rice (after DIC): 7 - 9 minutes

Is it possible to control the texture of powder particles during spray drying?

Impact of Instantaneous Controlled Pressure Drop (DIC)

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Powder

Definition

- Powder: is a population of particles for which the dimensions are usually less than 1mm.
- Fine Powder: the particle size is < 100 µm, from 10 to 100 µm

Powders in the food industry

70% of industrial products:

- Raw materials (flour, sugar),
- Final products or intermediaries (instantaneous preparation for soups, desserts, drinks).
- Texturing or aromatic products (jellifying, emulsifying, etc).

Functionality and specific surface area σ

- The main functional properties of powder are linked to the specific surface area.
- In general (for compact granule): particle size define the specific surface area

Estimation of σ

Hypothesis: spherical compact granules with first approach:

The specific surface area σ is conversely proportional to mean particle size of powder:

$$\sigma = n \cdot s = n \cdot 4\pi D^2 / 4 = (m/\rho) / [(4/3)\pi D^3 / 8] \cdot 4\pi D^2 / 4$$
$$\Rightarrow \sigma = 6m / \rho D.$$

Specific Surface area σ
in the approximation of compact spherical granules

$\sigma = n \cdot s = n \cdot 4\pi D^2 / 4 = (m/\rho) / [(4/3)\pi D^3 / 8] \cdot 4\pi D^2 / 4 = 6m/\rho D.$						
Diamètre D (µm)	1	10	100	1000	10000	100000
s (m²/litre)	6000	600	60	6	0.6	0.06

Powder manufacturing process

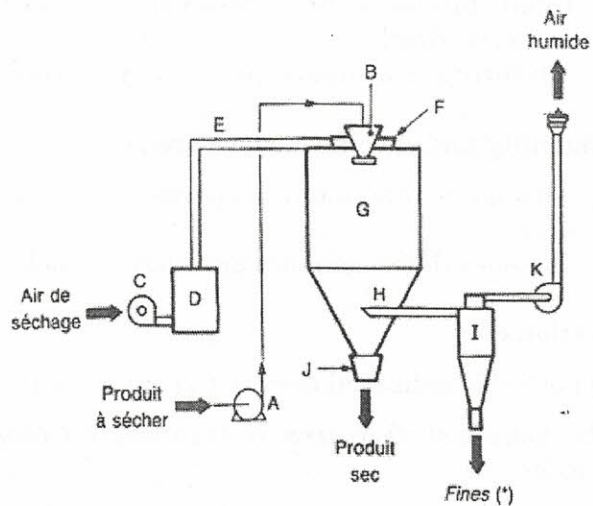
- Grinding or milling of dried product
- Spray drying of small droplets
- Drum drying



Spray drying

❖ Classical spray drying « one stage SD »

- Concentration,
- Spray/ drying,
- Recuperation of final powder
- Recycling of fines.



- A pompe d'alimentation du liquide
- B atomiseur (turbine ou pulvérisateur)
- C ventilateur d'entrée d'air
- D réchauffeur d'air
- E conduite d'air chaud
- F diffuseur d'air
- G chambre de séchage
- H prise d'extraction de l'air humide
- I cyclone de dépoussiérage
- J dispositif d'extraction du produit sec
- K ventilateur d'extraction de l'air humide
- L cheminée d'évacuation des gaz

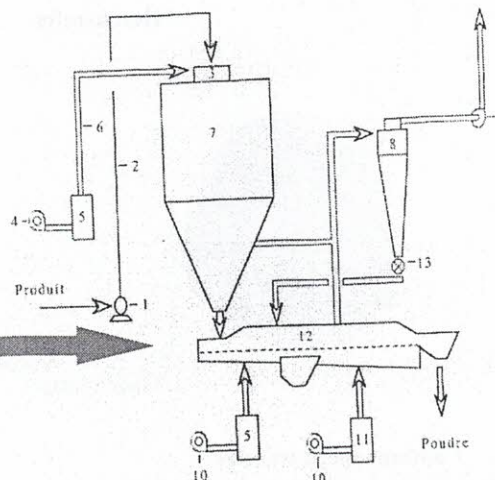
(*) Ces petites particules de produit sec peuvent éventuellement être recyclées dans la chambre de séchage

❖ Spray drying Classical Process 2 stage:

- Two stage SD:

SD: Liquid preparation, pre-concentration, Spray-drying, Powder separation.

*Vibro-fluidized drying
Coupled to a stage of Agglomeration*

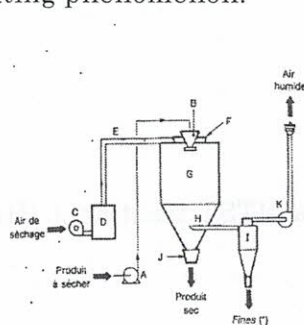


Vegetables and fruits powders: spray drying process

- Specificity: spray of concentrated matter
- Problems: low quality
- Granule: compact et presence of fine
- Biochemical: thermal degradation
- Hygienic: most of biological contamination
- Functionality: poor functional properties (solubility, wettability, dispersibility)

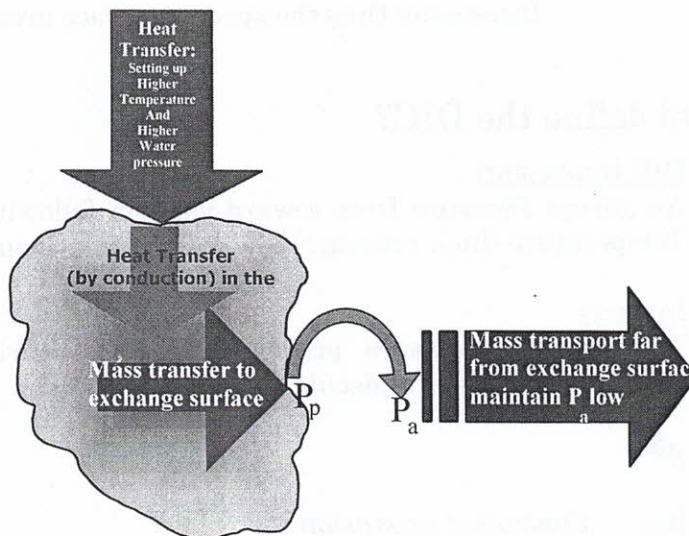
Let's analyze Drying Process:

Drying = Four coupled phenomena of heat & mass transfer from which one is the limiting phenomenon.

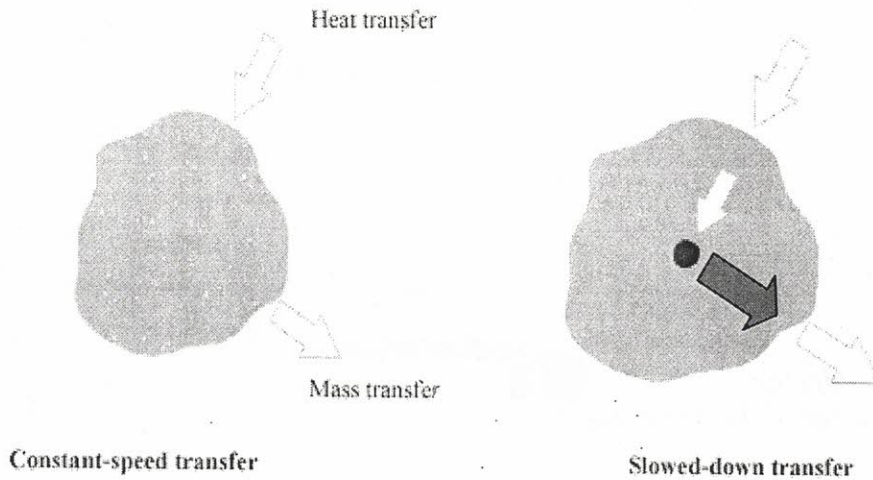


- A pompe d'alimentation du liquide
- B accélérateur/turbine du pulvérisateur
- C ventilateur d'entrée d'air
- D réchauffeur d'air
- E conduite d'air chauffé
- F effluveur d'air
- G chambre de séchage
- H zone d'extraction de l'air humide
- I cyclone de déshumidification
- J dispositif d'extraction du produit sec
- K ventilateur d'extraction de l'air humide
- L cheminée d'évacuation des gaz

(*) Ces petites particules de produit sec peuvent éventuellement être recueillies dans la chambre de séchage



Spray drying often, limiting phenomenon is the internal mass transfer



Solution

- Expansion by Controlled Instantaneous Pressure Drop DIC following by « rigidification » Of the new texture:
- To operate by « autovaporisation » expansion of granules after their spraying and before final drying
- Creation of vacuoles and return the granule porous and having open texture.
- Increasing thus the specific surface area.

How to define the DIC?

DIC treatment:

An abrupt Pressure Drop toward vacuum following a HTST treatment (High Temperature (high pressure) Short Time treatment)

Impacts

The drop of pressure provokes an autovaporization generally texturing polymers and other molecules



Controlled expansion
Instantaneous cooling!

DIC Treatment

DIC is a 4 stage treatment:

- 1- Setting up an initial vacuum
- 2- Injection and maintain a high steam pressure
- 3- Dropping of pressure abruptly toward vacuum;
- 4- Putting back the product at atmosphere pressure.

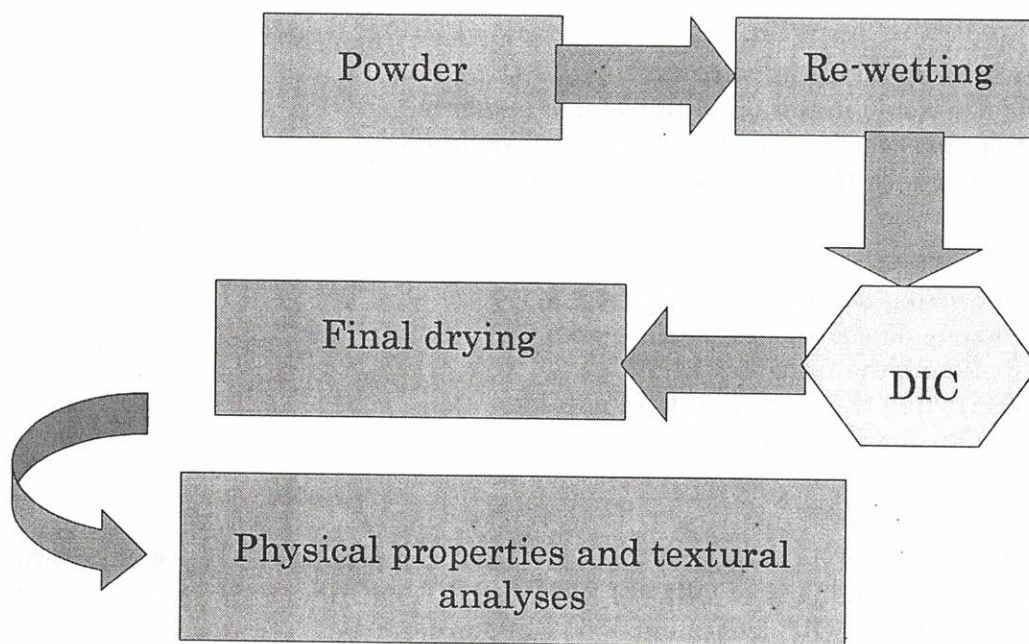
Objectives

- Improving the spray drying process
- Increasing the specific surface area
- Reducing the fines
- Improving the total quality of powder
- Enhancing the powder texture

Materials & methods

- Raw materials : skim milk "low temperature) & whey proteins powders (produced at INRA of RENNES, FRANCE)
- *DIC reactor* : DIC treatment « 50 g of powder »
- *Oven Dryer* : final drying at 50°C by convection
- Analyses :
 - Drying kinetics analysis : $W = f(t)$
 - Particle size distribution analysis : 0.071, 0.2, 0.6, 1, 1.4, 1.7 mm
 - Specific surface area analysis (m^2/kg) : « BET, degas during 6 h »
 - Bulk, tapped and real densities analysis- Compressibility analysis : CARRE correlation
$$\% \text{ of compressibility} = 100 (\rho_p - \rho_a) / \rho_p$$
 - Porosity analysis
$$\varepsilon = 1 - (\rho_p / \rho_{re})$$
 - Electronic scanning microscopy analysis

- Experimental Protocol



- Plan design for skim milk powder

points	Hot air			Steam "low temperature"		
	(bar)	Humidity (%)	Time (s)	Pressure (bar)	Humidity (%)	Time (s)
+ α	7	22	55	0,8	22	30
- α	1	4	5	0,2	4	4
Central point	4	13	30	0,5	13	17
+1	5,7	18	44	0,7	18	25
-1	2.3	8	16	0,3	8	9

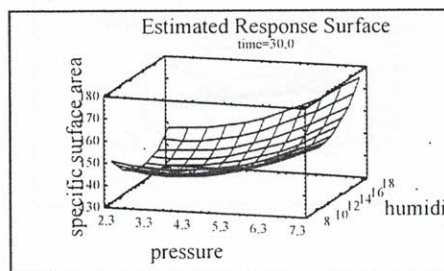
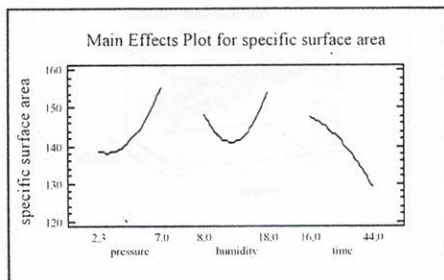
- Plan design for whey proteins powder

points	Hot air			Steam "low temperature"		
	Pressure (bar)	Humidity (%)	Time (s)	Pressure (bar)	Humidity (%)	Time (s)
+ α	7	18	55	0,8	18	30
- α	1	8	5	0,2	8	4
Central point	4	13	30	0,5	13	17
+1	5,7	16	44	0,7	16	25
-1	2.3	10	16	0,3	10	9

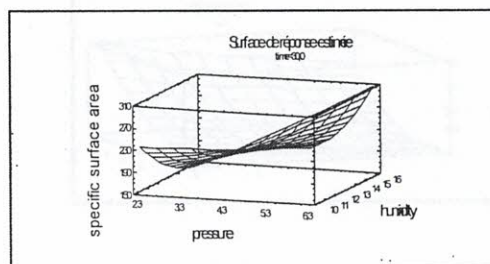
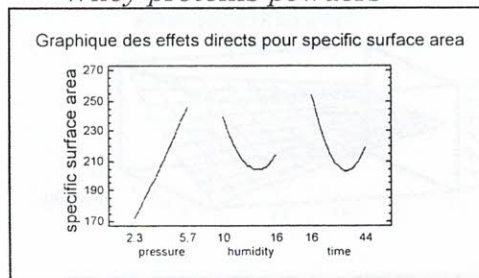
Results & discussion

Specific surface area

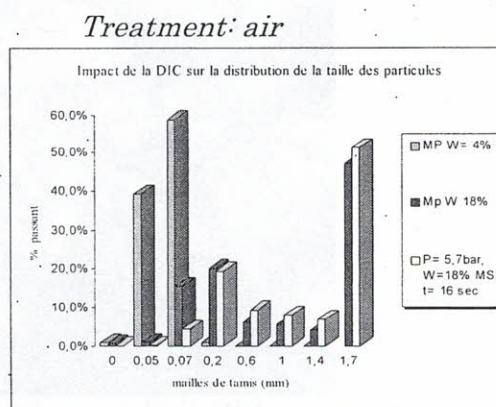
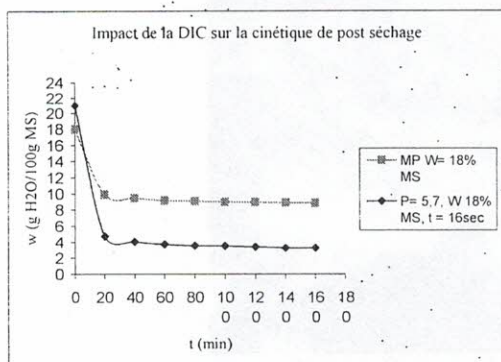
Skim milk powders



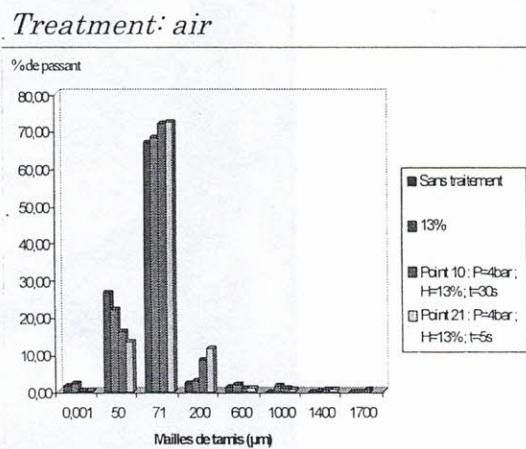
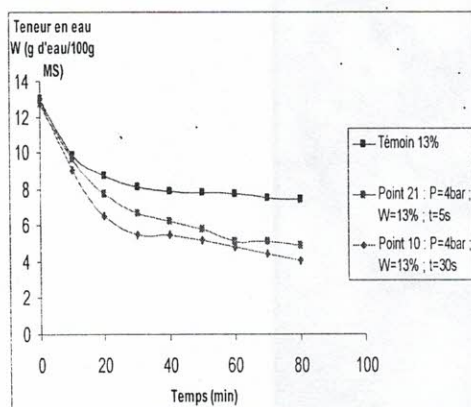
Whey proteins powders



Skimmed milk powders

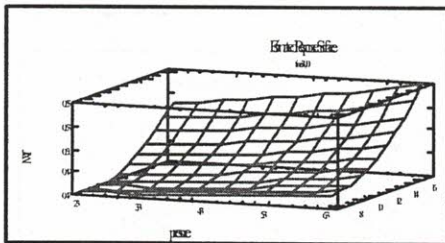
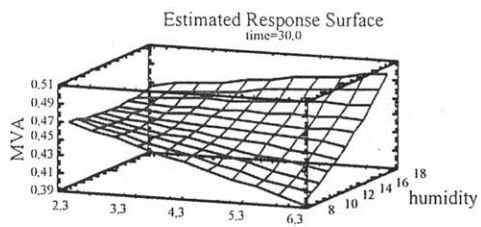


Whey proteins powders

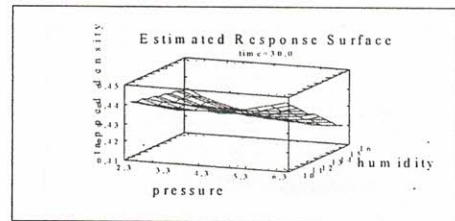
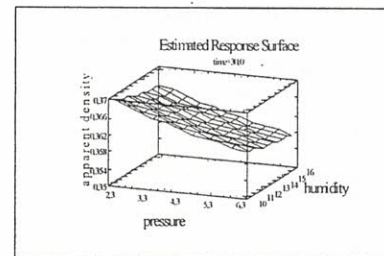


- Bulk and tapped densities

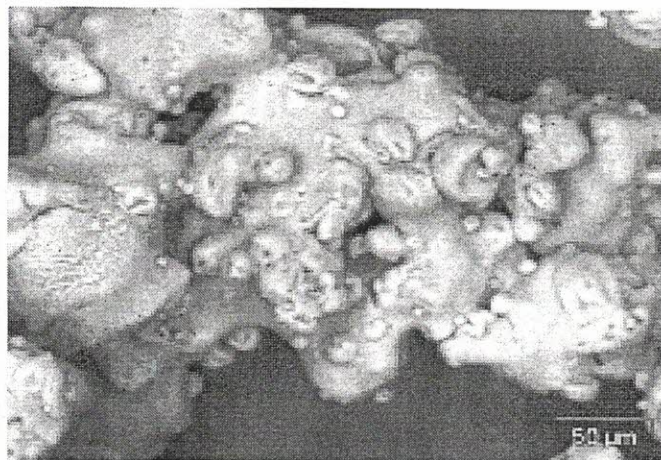
Skim milk powders



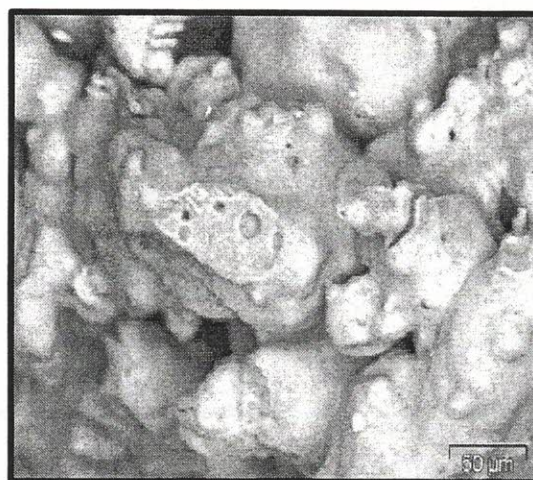
Whey proteins powders



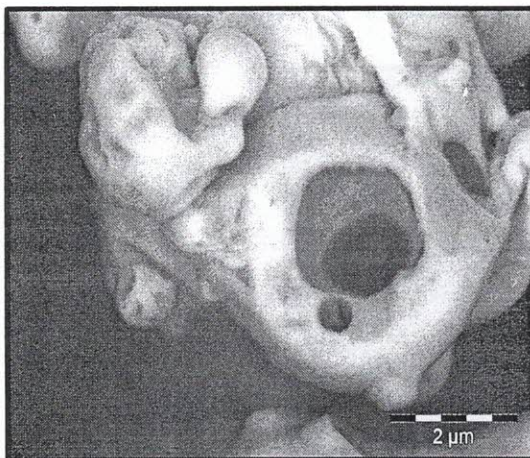
- Microstructure of skim milk powder



Classical spray-dried skim milk powder



Rewetted skimmed milk powders at 8% DB



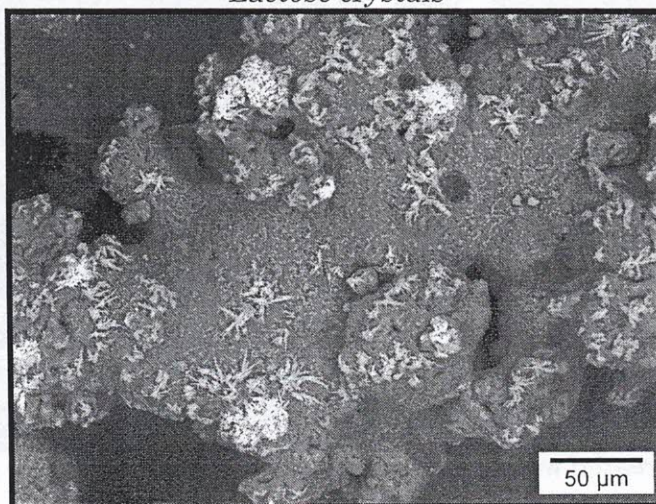
DIC treated skimmed milk powder
P= 2.3 bar , W=8 % DB, t= 16 sec

▪ Functional properties

	Solubility « % »	Wettability « s »	Dispersibility « % »
Raw material "skim milk powder"	100	120	79
Rewetted skim milk powder	72	4	50
DIC treated skim milk "swelled dried powder" (P= 5.7b, W 8%, t=44 s)	100	>120	81

▪ Microstructure of skim milk powder

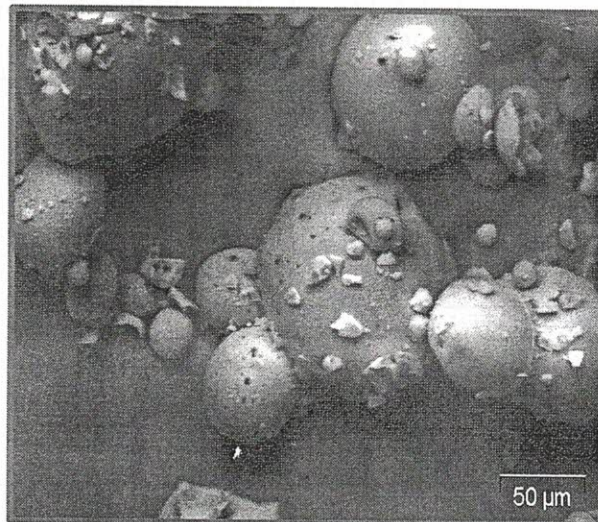
Lactose crystals



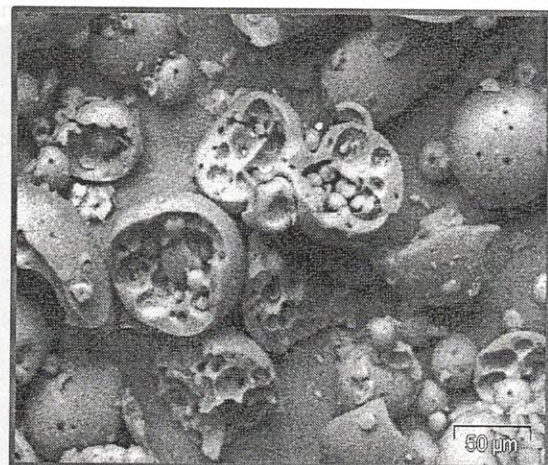
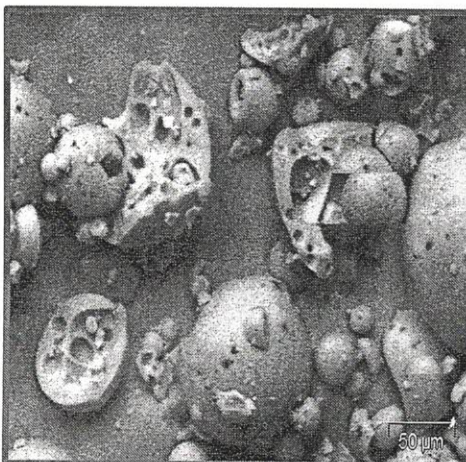
- Microstructure of whey proteins powders



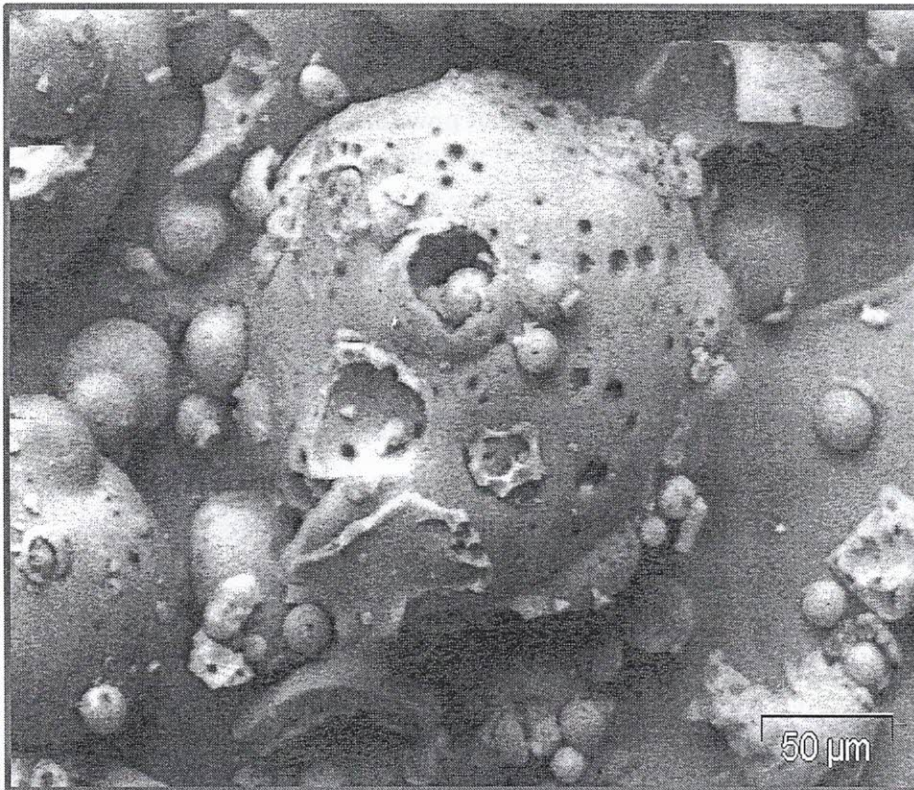
Classical spray-dried whey proteins powders



Rewetted whey proteins powders at 16%



DIC treated whey proteins powders at 4 bar, 13% DB, 5 s



DIC treated whey proteins powders at 4 bar, 13% DB, 5 s



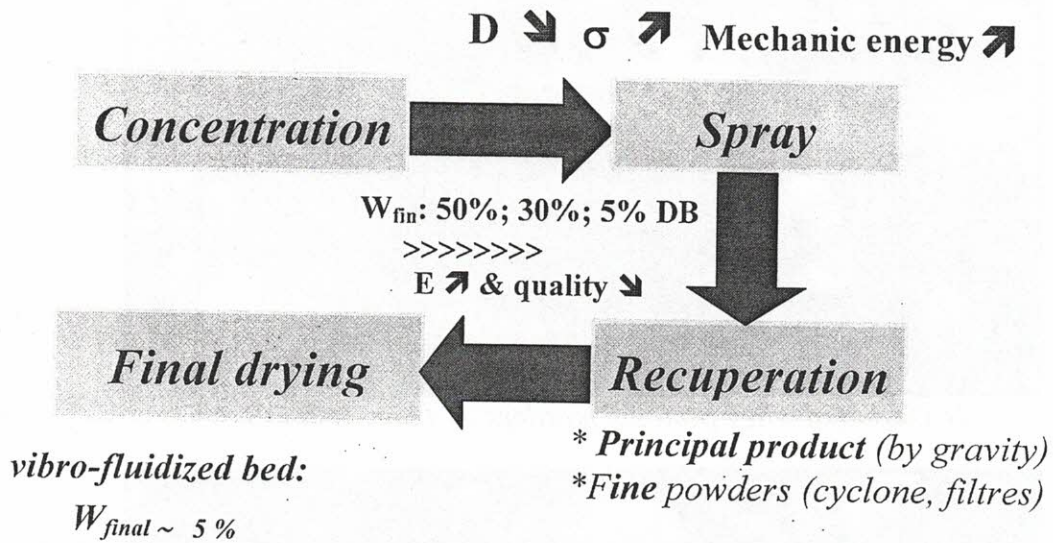
DIC treated whey proteins powders at 5.7 bar, 16% DB, 16 s

Conclusions

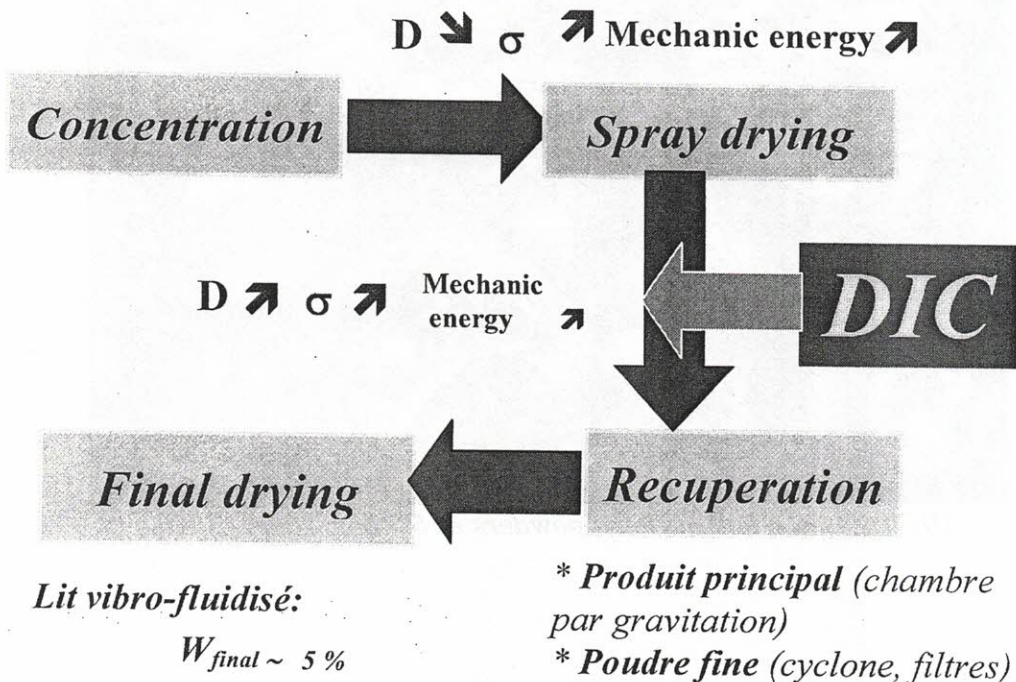
DIC treatment allows to

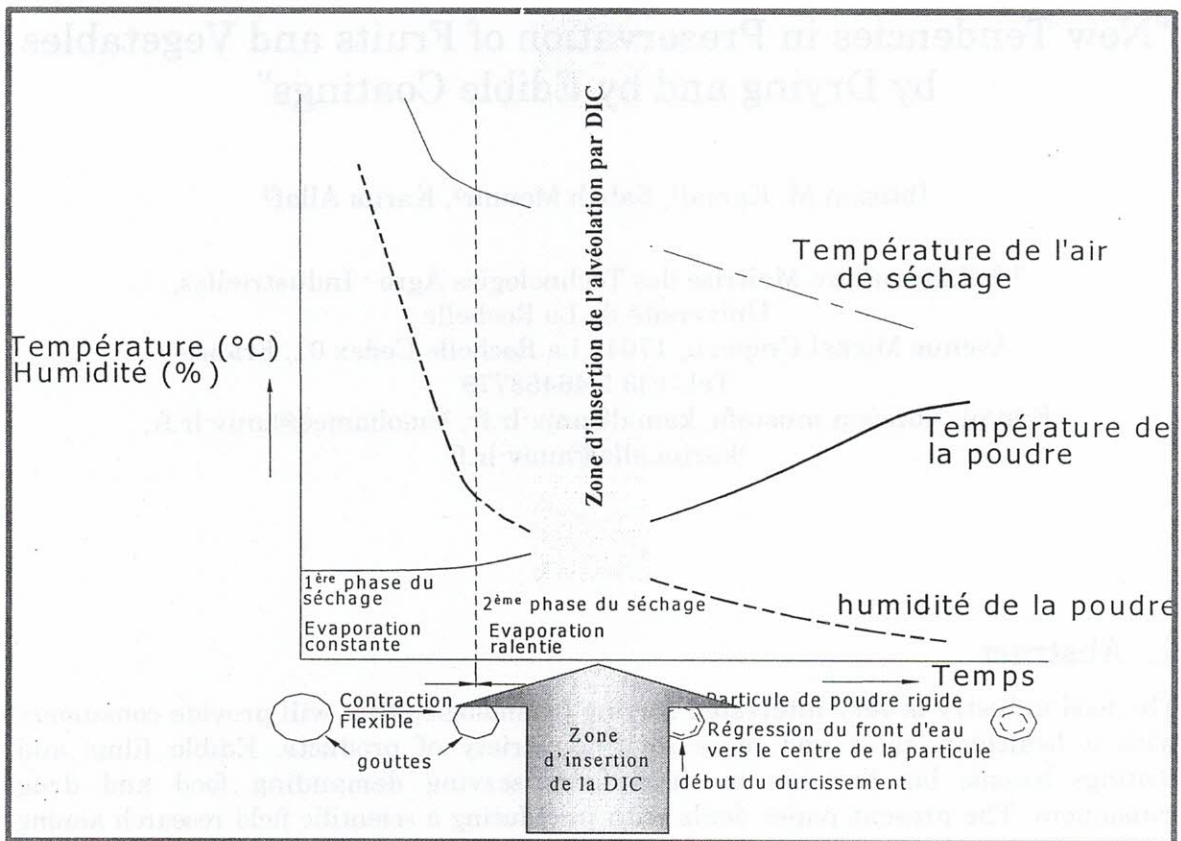
- Increase the specific surface area of powders
- Improve the physical properties of powders
- Reduce fine problems
- Improve the functional properties and enhance powders texture
- Define a 3 stage spray drying process "DIC-spray drying"

Classical spray drying



Innovated spray drying: 3 stage spray drying





“New Tendencies in Preservation of Fruits and Vegetables by Drying and by Edible Coatings”

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1. Abstract

The food industry is very interested finding technologies that will provide consumers with a healthier, safer and more inviting variety of products. Edible films and coatings become big business in these fields serving demanding food and drug consumers. The present paper deals with introducing a scientific field research aiming to give food and drug developers and processors an opportunity to solve specific preservation problems. We'll follow a new approach in order to establish multidimensional methodologies for preserving fruits and vegetables food using natural and food grade synthetic biopolymers as edible films and coatings. Some of such biopolymers are related to locally available natural resources.

Our interest focuses firstly on determination of the optimum and well established-standard design methods for preparing and evaluating some single and composite biopolymer edible coatings; we thus shall study their application field in preserving food quality. Secondly, research activities will interest on an innovative food processing technology for 1) specific biopolymers making 2) edible film coating preserving the film functionality, and 3) Combining with edible coatings the Instantaneous Controlled Pressure Drop (DIC) as a controlled high temperature and short time process.

The combination of DIC process with edible coatings will be conducted firstly for the preparation of the edible raw materials to enhance dissolution in the solvents needed to prepare their formulations, in addition to perform a precise sterilization. Secondly, as a first step of properly said treatment, DIC intervenes for preserving quality and decontaminating pieces of fruits and vegetables; it also may reduce even completely remove enzymatic activities. In the third step, optimal edible coating formulations will be used to coat some fresh or dried fruits and vegetables.

The developed coating materials adopted will be applied through the new combined technology to improve the eating quality and increase the shelf -life time of the processed foods.

2. Introduction

Edible films are thin layers of biopolymer material that are usually used for encapsulating food and pharmaceutical products. They are formed on the surface as protective or decorating foodstuffs coatings, or placed between food components to separate them. They can also be found as wrappings and pouches used to segregate sensitive ingredients in mixes, or as a means of delivering just the right amount of a pre-packaged ingredient.

The environmental friendly films and coatings are biocompatible and non-toxic and acceptable to human consumption.

Edible films have been applied to meat, poultry, fruits, vegetables, grains, and confectionery products, heterogeneous foods, any of which can be fresh, frozen, cured or processed.

3. Objectives

The objectives achieved from using edible films and coatings are:

- Maintain the quality and extend shelf life of food products.
- Decrease fruit peel permeability.
- Reduce the need of packaging materials and the amount of disposable non biodegradable packaging materials.

Edible coatings intervene by:

- Depressing food respiration rate.
- Serving as barriers for water vapor, oxygen, etc.

Their effect is reinforced by:

- Using a modified internal atmosphere.
- Reducing water vapor, oxygen, lipids and flavors migration in multicomponent food products between food and surrounding atmosphere.
- Serving as carriers for a wide range of food additives, including thermolabile compounds like vitamins, aroma and flavors, antioxidants and colorants, fortified nutrients, and/or spices providing an efficient method to preserve their characteristics during food processing.
- Reducing oil uptake in fried products.

They also may be used as an adhesive in snake foods seasonings (e.g. salt on dry roasted peanuts).

4. Functionality

The most important functionality of an edible film or coating includes:

1. Control of mass transfer.
2. Mechanical protection.
3. Sensory appeal.

The first functionality involves preventing foods from desiccation, regularity of gases around foods and controlling migration of ingredients and additives in food system. The adequate mechanical strength is necessary to protect the integrity of packaging throughout distribution,

While, sensory properties are a key factor for acceptance of final products.

Components of edible coatings can be hydrocolloids, proteins and lipids or composites of the three, by using additives one can modify the functional, organoleptic, nutritional and mechanical properties of almost any food product.

Various coating formulations were prepared and examined around the world using different tests. The most central biopolymers involved in those formulations are included in the following list:

- Methyl Cellulose (MC) and Ethyl cellulose (EC),
- Hydroxypropyl methyl ellulose(HPMC), Hydroxypropyl cellulose (HPC) ,
- Chitosan and its derivatives,
- Pectins,
- Been Gum,
- Xanthane Gum,
- Gellan gum,
- Pollulan,
- Sucrose polyester,
- Sodium Alginate,
- Sodium Caseinate,
- Wheat Gluten,
- Whey Protein,
- Gelatine,
- Milk protein,
- Zein,
- waxes and fatty acids.

5. Description of the Research

The research work we are carrying out on the edible coating systems need to concentrate on the following goals:

1. To develop coating formulations and processes for an industrial fabrication from waste of food industry.
2. To develop composite film systems that can be applied to foods using pilot-scale coating application efficiency, adhesion, durability and effectiveness for foods.
3. To investigate on optimal film types and compositions (quantity to apply) and specific film - forming and drying conditions for different food systems.

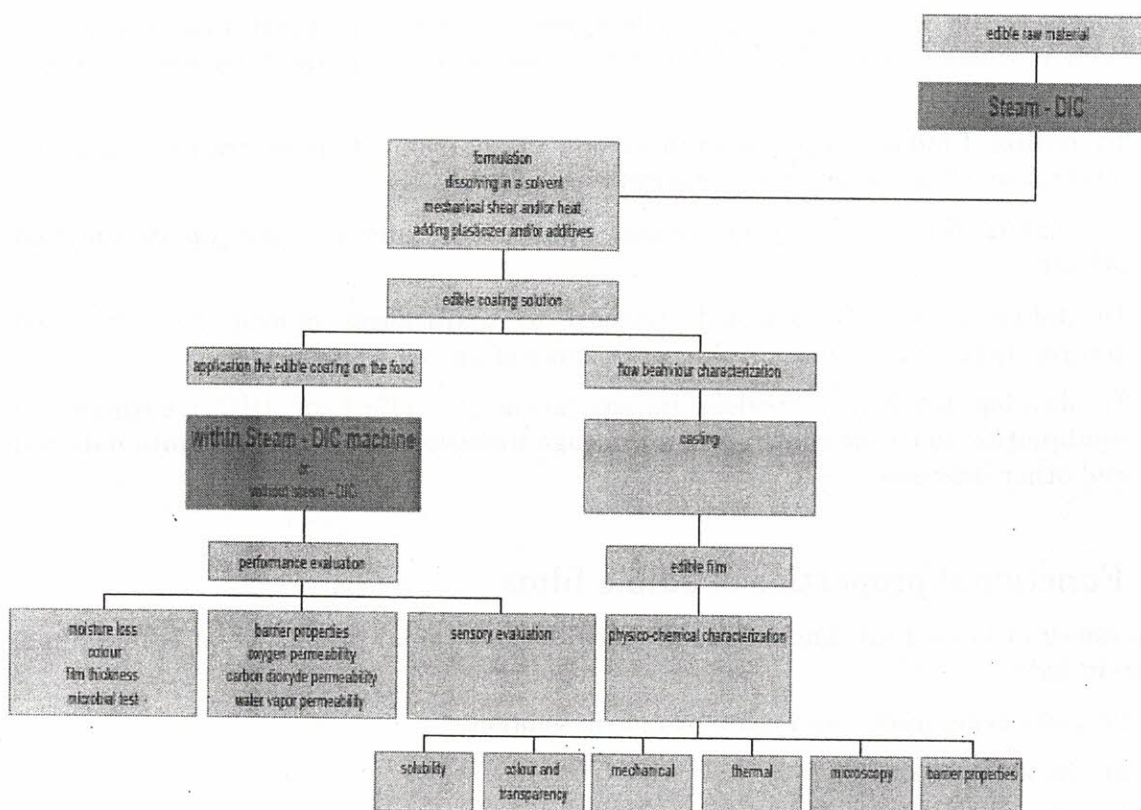
4. To study the film properties and behavior as barrier to environmental factors such as water vapor, pH and temperature, mechanical, thermal, microscopical, and solubility.
5. To realize fundamental research of the mechanism of mass transfer and the interaction of different films components and foods.
6. To explore the feasibility of various applications and to scale up in the food industry.
7. To define a specific detailed protocol to characterize coating materials and determine their influence on the performance of the coated materials.
8. To develop predictive models incorporating the effect of DIC treatment in combination to edible coatings to encourage inclusion of such models into national and other databases.

6. Functional properties of edible films

A number of factors are known to influence the functional properties of edible films, these include:

1. Polymer type, purity and concentration in solution.
2. Method of preparation:
 1. Effect of dissolving solvent.
 2. Effect of pH.
 3. Plasticizers or additives used.
 4. Film drying temperature.
3. Intrinsic food properties (pH, water activity, and composition).
4. Extrinsic factors (i.e. temperature and relative humidity) in processing and storage conditions.

With greater understanding of films and coating properties, edibles can be effectively engineered for large domain of food products.



Flow chart of manufacturing, processing and application of edible coatings

7. Technical and economical advantages

The main technical and economical advantages of this field of research are:

1. To minimize food wastes.
2. To preserve foods shelf-life time, this will reflect positively on conservation of energy needed for storage.
3. To control the storage and some quality of foods; the coating films are able to transfer flavors to foods, add health-promoting vitamins and reduce surface contamination of the products.
4. To get relatively simple and cheap equipments for applying the coating materials.

We note that the coating processes and the coating materials costs are well justified by the long shelf - life time and preserved food quality.

5. The combination of DIC-Edible coating process preserves time and energy needed to obtain lightly processed food, in addition to the controlled and precise sterilization, texturization and preservation of both fresh and dried foods.
6. The inclusion of DIC process can be also performed as a pre-treatment step for the edible raw materials to enhance the dissolution of these raw materials in the solvents used to prepare their formulations, in addition to create superior sterilization.
7. The shiny appearance and the unchangeable taste of the coated foods are in line with consumer acceptance.

8. The results obtained lead to assemble Pilot - scale equipments to begin studying processing parameters of importance to forming individual developed coatings on foods in a commercial setting.
9. The closely working with a food industry partner will gather additional necessary data towards commercialization of the edible coating technology, in addition to create an environment where practical applications are created for an existing market.

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cactus mucilage edible coating and its application to extend strawberry shelf life.
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Swell-Drying Process

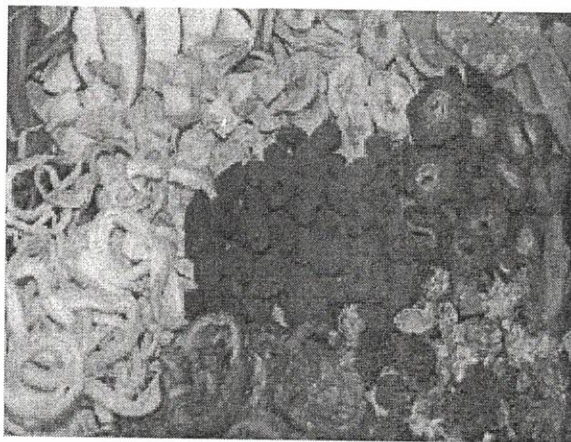


Fig. 2. Example of swell-dried products.

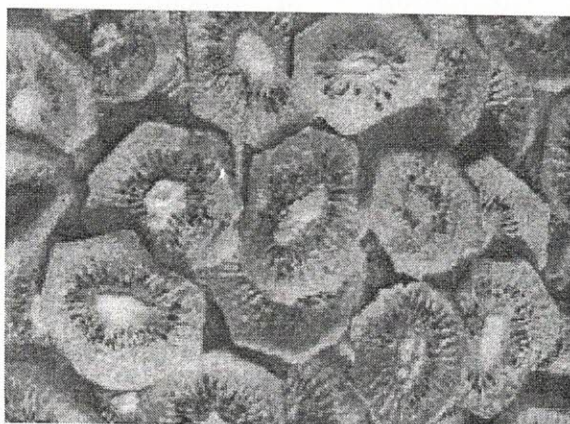


Fig. 3. Swell-dried kiwis



Fig. 4. Swell-dried red peppers

Internal resistance limits the dehydration rate of capillary porous materials especially during the last drying stage. Most of the products reveal an important degree of shrinkage that contributes to the decrease of effective moisture diffusivity with drying time. Expanding partially dried foods (water content around 20%-dry basis) is a valuable alternative both for increasing the drying rate and improving final product quality.

Drying kinetics shows the beneficial effect of DIC incorporation into the hot-air drying process. The introduction of an equilibration step during which the water of the product is homogenized after initial drying, significantly reduces the duration of final drying step.

General patterns were discussed for the variation in the expansion ratio as a function of saturated steam pressure, exposure time to high pressure and temperature, initial water content of the product and thickness of the pieces. DIC technology can be used to control the quality of the final product and also to provide dried vegetables with a cooking time of one minute compared with approximately 15 min immersion in boiling water needed for vegetables classically dried with hot-air to cook them properly. The use of atmospheric air flow injected just after decompression may intensify cooling effect; it may allow low hardening temperature products to avoid final shrinking and fixes them in an expanded state. Creation of a vacuum in the processing vessel before the steam injection enables DIC to be successfully used with thick pieces of product (approx. 15 cm).

The overall impact of DIC technology results in saving time and drying costs together with an improvement in finished product quality. It was successfully industrialized for different types of vegetables such as tomatoes, red and green peppers, green beans, peas, onions, leaks, garlic, cabbage, cauliflower, broccoli, carrots, potatoes, turnips, parsnip as well as many fruits such as strawberries, apples, kiwis, bananas.

Swell Instantaneous Extraction of Essential Oils: Case of Ylang Ylang Flowers

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1. Abstract

We studied here the extraction of Indonesian ylang-ylang oil by Instantaneous Controlled Pressure Drop (DIC®) process. This process involves subjecting the dried ylang-ylang (*Cananga odorata* Hook. fil. et Thomson, forma *macrophylla*) flowers for a short time to a steam pressure, followed by an abrupt pressure drop into vacuum (about 50 mbar). This abrupt pressure drop provokes simultaneously auto-vaporization of the volatile compounds, instantaneous cooling, swelling of the structure and breaking of cellular walls. We dedicated the first part of our research for investigating the effect of DIC® processing parameters, namely DIC® cycle (1-9), steam pressure (2-6 bar), and total processing time (0.5-20 minutes) on the essential oil yield and its composition. The results indicated a significant increase of oil yield with increasing processing pressure and number of DIC® cycles, however the processing time was not a significant parameter. The DIC has been compared with a conventional technique, steam distillation (SD). The DIC® exhibited better results than SD in terms of rapidity (4 min versus 24 h), oil yield (2.74% versus 2.60%) and also oil quality. The second part of our work was dedicated on the analysis of residual flowers. We have realized the comparative study between organic solvent extraction of untreated flowers and that of DIC® treated flowers. The DIC® treatment increases the availability of the Heavy Oxygenated Compounds and non-volatile molecules in the flowers. Microscopical examination of cross sections of untreated and DIC® treated flowers showed the impact of the DIC® treatment on the modification of internal structure.

Keywords: *Ylang-Ylang (Cananga odorata Hook. fil. et Thomson, forma macrophylla), extraction, essential oil, steam distillation, Instantaneous Controlled Pressure Drop DIC®*

2. Introduction

The ylang-ylang tree, *Cananga odorata* Hook. fil. et Thomson, is a native of tropical Asia. Its essential oil is one of the most important perfume raw materials [1]. This oil is also used extensively in soap and detergents, aromatherapy, pharmaceutical industry, cosmetics and food flavors [2, 3, 4, 5, 6].

Ylang oil is isolated by steam distillation and sometimes by solvent extraction from fresh mature flowers [2, 3]. Low yield, losses of volatile compounds, long extraction

times, toxic solvent residues, and degradation of unsaturated compounds, giving undesirable off-flavour compounds, due to heat may be encountered using these extraction methods [2, 7, 8, 9, 10]. These shortcomings have led to the consideration of the use of supercritical fluids in essential oil extraction processes. CO₂ is the most commonly used supercritical fluid because of its modest critical conditions. Furthermore, the supercritical CO₂ extraction of aromatic plants gives high quality and solvent-free extracts [9, 10, 11, 12, 13, 14, 15, 16]. However, its high cost related to specific equipments for high pressure conditions (200 bar), requirement of CO₂ purity and CO₂ low dielectric constant (thus giving rise to a non-polar character that hinders or makes difficult the extraction of polar compounds) make important the searching for new extraction method [17, 18].

The need of more rational technique for obtaining high quality essential oils has led our laboratory to develop a new and alternative extraction process by Instantaneous Controlled Pressure Drop (DIC®) [19]. The DIC® process is based on the thermo-mechanical effects induced by subjecting the raw material for a short period of time to a saturated steam pressure (about 1 to 6 bar according to the product), followed by an abrupt pressure drop towards vacuum (about 50 mbar). This abrupt pressure drop ($\Delta P/\Delta t > 5 \text{ bar.s}^{-1}$) provokes simultaneously auto vaporization of volatile compounds, instantaneous cooling of the products allowing to stop thermal degradation, swelling and eventually implies the rupture of cell walls, which enhances the global mass transfer.

The main objective of this work was to determine the optimum parameters of DIC® process on the ylang oil extraction, and compare the results with oil obtained by steam distillation. We intend to make appropriate comparison in term of extraction yield and oil composition.

3. Experimental

To investigate the potential of DIC® the analysis of residual flowers and DIC® extracted oil were carried out according to the protocol shown in Fig. 1.

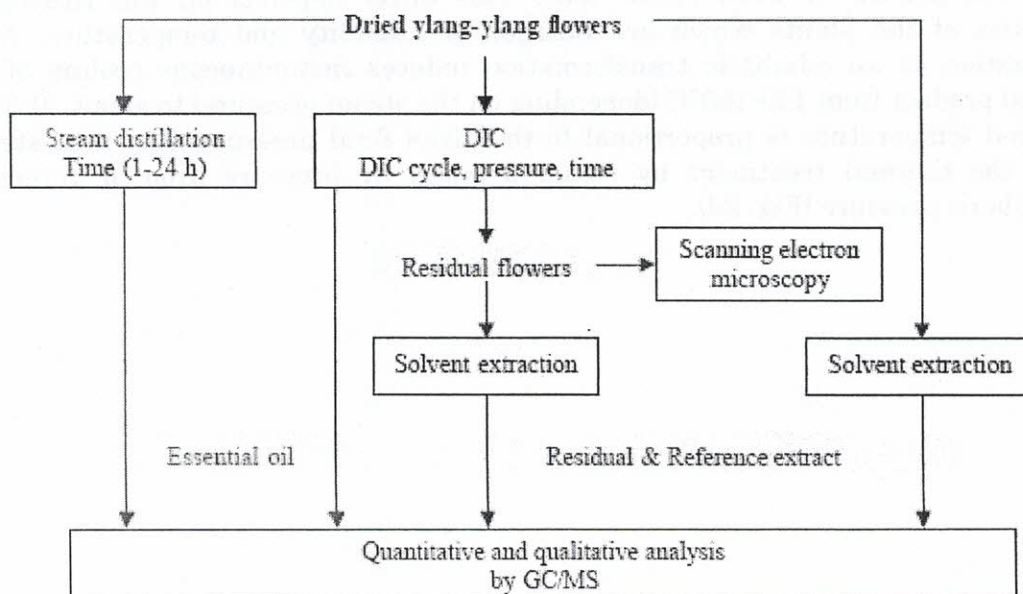


Figure 1: Protocol for the evaluation of DIC® performance on ylang oil extraction

In this work, we have studied 3 parameters of DIC® process: (1) The processing steam pressure which varied from 2 bar up to 6 bar; (2) The total processing time varied from 0.5 to 20 min and (3) The number of DIC® cycle varied from 1 to 9

4. Materials

Fully mature Ylang-Ylang flowers (*Cananga odorata* Hook. fil. et Thomson, forma *macrophylla*) were picked up at blossom in Lawang, East Java, Indonesia (October 2003). The flowers were air-dried to a final moisture content of 10.2 % dry basis and stored at room temperature prior to use.

4.1. Extraction methods

4.1.1. *DIC® apparatus and procedure*

The schematic diagram of the equipment used has been described in a previous study [20]. This equipment is composed of three main elements:

- The autoclave where the flowers were placed and treated
- The vacuum system which consists mainly of a vacuum tank with volume 100 fold greater than the processing vessel and a vacuum pump
- A pneumatic valve, which separated the processing vessel from the vacuum tank, can be opened in less than 200 ms to assure instantaneous pressure drop.

40 g of dried ylang-ylang flowers was treated in the autoclave in which a vacuum of 50 mbar was established by a brief connection with the vacuum tank. The initial vacuum treatment (Fig. 2a) facilitates the diffusion of steam into flowers. Consequently, the time necessary for the temperature of the flowers to reach that of the steam is reduced. Saturated steam is then injected into the autoclave at a fixed pressure level (Fig. 2b) and maintained for a predetermined time. An abrupt pressure drop follows this step (Fig. 2c). The equilibrium pressure after pressure drop depends on the operating pressure in the autoclave: the higher the operating pressure, the higher the equilibrium pressure. The vapour in the Ylang-Ylang flowers created by auto-vaporization after instantaneous pressure drop produces mechanical stresses which can deform or even break cells. This effect depends on the rheological properties of the plants which are function of humidity and temperature. Auto-vaporization as an adiabatic transformation induces instantaneous cooling of the residual product from 120-160°C (depending on the steam pressure) to about 30-35°C. The final temperature is proportional to the given final pressure. The next step is either the thermal treatment by steam followed by pressure drop or return to atmospheric pressure (Fig. 2d).

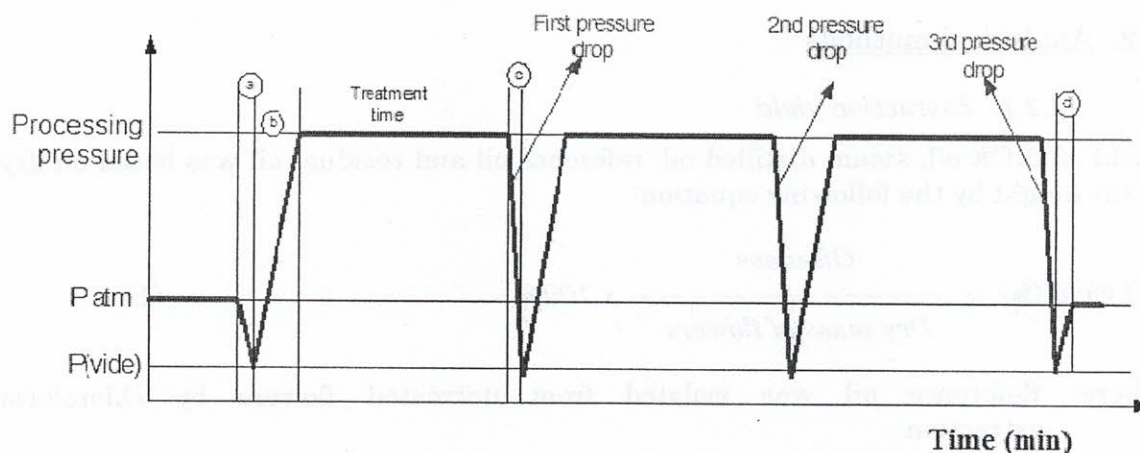


Figure 2: Several cycles of DIC® treatment

For several cycles of DIC® treatment, the treatment time of 1 cycle of DIC® is defined as the total processing time to the number of DIC® cycle ratio

After DIC® treatment, the condensate (oil in-water emulsion) was recovered from an extract container which connected to the vacuum tank. The vacuum tank is equipped with cooling water jacket. Then this emulsion was subjected to liquid-liquid extraction step in order to isolate essential oil

For residual analysis, the residual oil was extracted with chloroform from the treated flowers and analysed by GC MS, whereas the structure of the treated flowers was investigated by the Scanning Electron microscopy.

4.1.2. Steam distillation of flowers

A packed bed of 80 g of dried ylang-ylang flowers was put on a stainless steel grill fixed above 2 L of water in the extraction vessel. The steam, which is produced in the lower part of the apparatus by electric heating, passes through the ylang bed evaporates and carries the essential oil. These vapours are condensed and the water is recycled into the extraction vessel.

4.1.3. Liquid-liquid extraction of the aqueous extracts

Prior to analysis, the critical stage was the oil separation from the condensate obtained after the steam distillation and DIC® extraction. The condensate was extracted three times with chloroform with addition NaCl to facilitate the emulsion breakdown. Sodium sulphate was added to remove moisture and the organic phase was then dried under vacuum in a rotary evaporator at 30°C. Each dried sample was diluted with chloroform to 20 ml and stored in the dark at 4°C prior to yield and composition analysis by GC-MS.

4.1.4. Solvent extraction of flowers

4 g of the dried Ylang-ylang flowers was extracted according to Randall technique [21] with 80 ml of chloroform at its boiling point by using Velp Scientifica SER 148 extractor. Then the solution was dried under vacuum in a rotary evaporator at 30°C. Each dried sample was diluted with chloroform to 20 ml and stored in the dark at 4°C prior to yield and composition analysis by GC-MS.

4.2. Analytical methods

4.2.1. *Extraction yield*

Yield of DIC® oil, steam distilled oil, reference oil and residual oil was based on dry plant weight by the following equation:

$$\text{Oil yield (\%)} = \frac{\text{Oil mass}}{\text{Dry mass of flowers}} \times 100 \% \quad (1)$$

where: Reference oil was isolated from untreated flowers by chloroform extraction

Residual oil was isolated from DIC® treated flowers by chloroform extraction

Oil mass was computed from GC peak area of all volatiles molecules.

Concrete yield was measured gravimetrically and calculated based on dry plant weight.

$$\text{Availability of compounds } i \text{ in residual flowers} = A_i/A_o \quad (2)$$

where A_i = yield of compound i in residual oil

A_o = yield of compounds i in reference oil

The yield of compounds i was computed from GC peak area.

4.2.2. *Gas chromatography-mass spectrometry identification*

The volatile molecules were analysed by gas chromatography coupled to mass spectrometry (GC-MS) A Varian computerized system comprising a 3900 gas chromatograph equipped by a fused-silica-capillary column with a non-polar stationary phase poly (dimethylsiloxane) CPSil 8 (30 m x 0.25 mm x 0.25 μ m film thickness) was connected to a 2100T mass spectrometer. The measurements were performed under the following conditions: carrier gas He; flow rate 1 mL.min⁻¹; split 1:100; injection volume 0.1 μ L; injection temperature 250°C; oven temperature progress from 60 to 170°C at 2.5°C.min⁻¹, from 170 to 250°C at 10°C.min⁻¹ and holding at 250°C for 5 min; the ionisation mode was electronic impact at 70 eV. Mass spectra and reconstructed chromatograms were obtained by automatic scanning in the mass range m/z 30-400 a.m.u at 2.2 scan.s⁻¹. Identification of the components was achieved by a comparison of their mass spectral fragmentation patterns with those stored in the data bank (Varian NIST MS Database 1998 and Saturn libraries) and the literature [22, 23]. Quantitative analysis was performed by peak area measurement.

4.2.3. *Scanning electron microscopy*

Scanning electron micrographs of the untreated and DIC® treated flowers were taken with a Jeol 5410 LV SEM with the aim to observe their structural changes.

5. Results and discussion

5.1. Analysis of direct DIC® oil

5.1.1. Essential oil yield

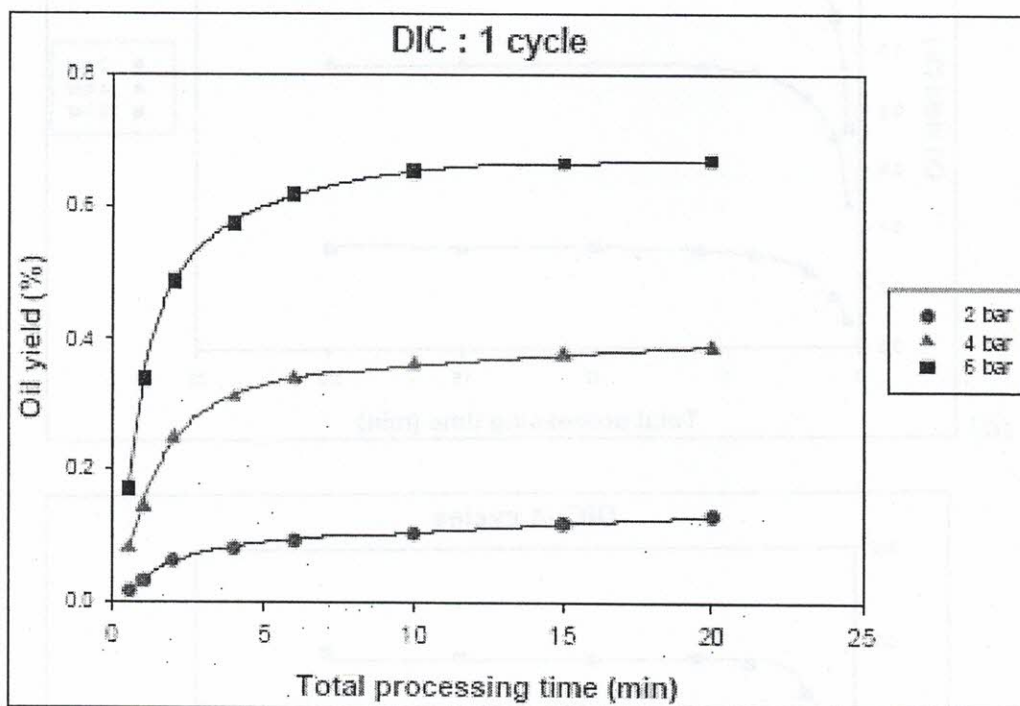


Figure 3 : Effect of pressure and total processing time of DIC® with 1 cycle on oil yield

The oil yield increases with increasing pressure and total processing time (see Fig. 3). The increase is considerable during the first 10 min. The processing pressure has a significant effect on the oil yield while the effect of total processing time after 10 min was not significant. When the pressure increases from 2 to 6 bar for a total time of 10 min, the oil yield increases from 0.11% to 0.65%. However, oil yield obtained by DIC® with 1 cycle is very low (less than 1 %) in comparison to yield of industrial steam distilled oil from fresh flowers (about 2.0-2.5%) [24]. In order to increase oil yield, therefore the DIC® extraction was carried out with several cycles and varying the processing time from 30 s to 20 min and pressure from 2 to 6 bar (see Fig. 4)

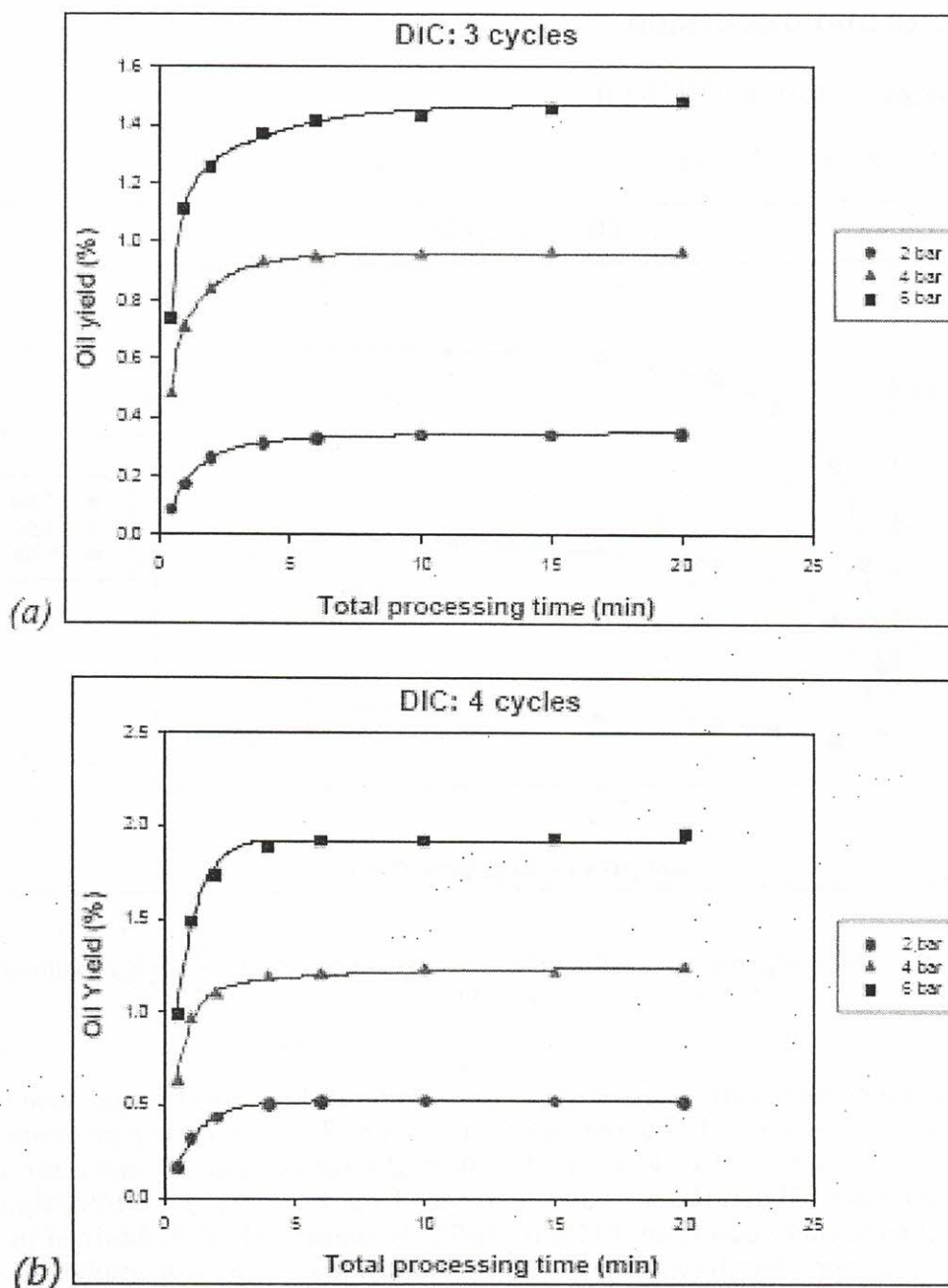


Figure 4 : Effect of pressure and total processing time of DIC® with several cycles on oil yield

The yield obtained by DIC® with several cycles (see Fig. 4) has the same tendency as that of 1 cycle. The oil yield increases essentially with increasing pressure and total processing time during the first 6 min.

A closer look at Figs. 3 and 4 shows that the increasing of number of cycle from 1 to 4 cycles at pressure 6 bar improve the oil yield three times; from 0.65% to 1.92%. Besides that, the increasing of processing pressure from 2 bar to 4 and 6 bar for 4 cycles improve the oil yield two times; from 0.52% to 1.20% and four times, from 0.52% to 1.92, respectively.

Interestingly, Figs. 3 and 4 also show that the more and more number of cycles, the shorter total processing time required for achievement of maximum yield (4 cycles in 6 min vs. 1 cycle in 10 min). After 4 cycles, the extended total processing time greater than 6 min results only a small gain in oil yield. Therefore, the total processing time was maintained at 6 min for further study of DIC® cycle and processing pressure.

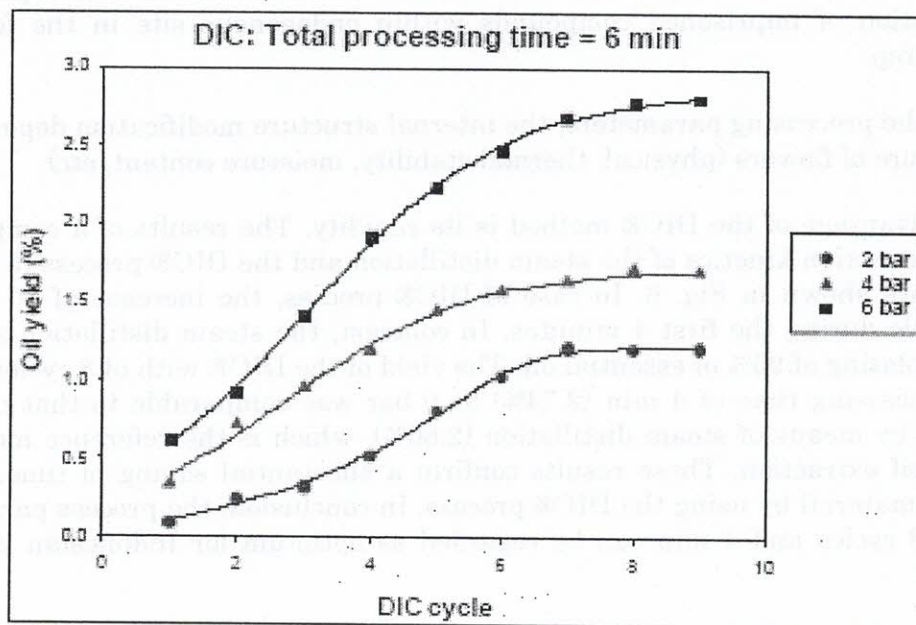


Figure 5 : Effect of DIC® cycle and processing pressure on oil yield

Oil yield as a function of the number of DIC® cycle is shown in Fig. 5. The oil yield increases significantly with increasing processing pressure and DIC® cycle. The oil yield achieved maximum after 8 cycles whatever the pressure used. It appears that the best result can be obtained at 6 bar with 8 cycles in 6 min with an oil yield of about 2.77%.

An overall evaluation of the data from Figs. 3, 4 and 5 shows the most significant parameters of DIC® process are the processing pressure and the number of cycle. The processing time is less significant. The effective time for each cycle is defined as the required time of heating steam for achievement of thermal equilibrium (the flowers temperature in the bulk is the same as that of steam) and rheological equilibrium (the achievement of flowers viscoelasticity required for swelling) [25]. It seems that a heating time of 45 seconds for each cycle (8 cycles in 6 min) is sufficient to reach the equilibrium conditions in case of ylang flowers.

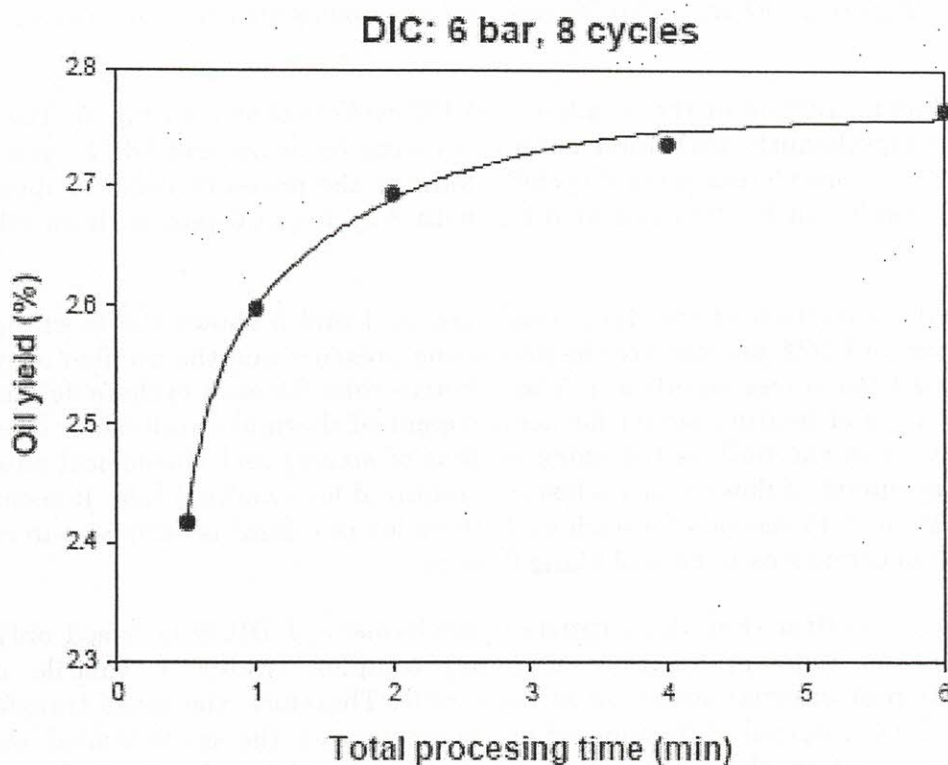
These facts confirm that the extraction mechanism of DIC® is based only on the instantaneous auto-vaporization of liquid complex (water + volatile oil) and modification of internal structure at each cycle. Therefore, the mass transfer is not controlled by internal diffusion, which characterizes the conventional extraction process. In addition, the compounds-solid matrix interaction that leads to importance of auto-vaporization of these compounds from the modified structures needs to be taken into account when considering the overall extraction kinetics. This is the explication for S-shaped of yield-cycle plot in Fig. 5 for DIC® with pressure of 6 bar. We observed a slow rate of rise at first cycle and then speeding up before dropping to

zero at the last cycle.

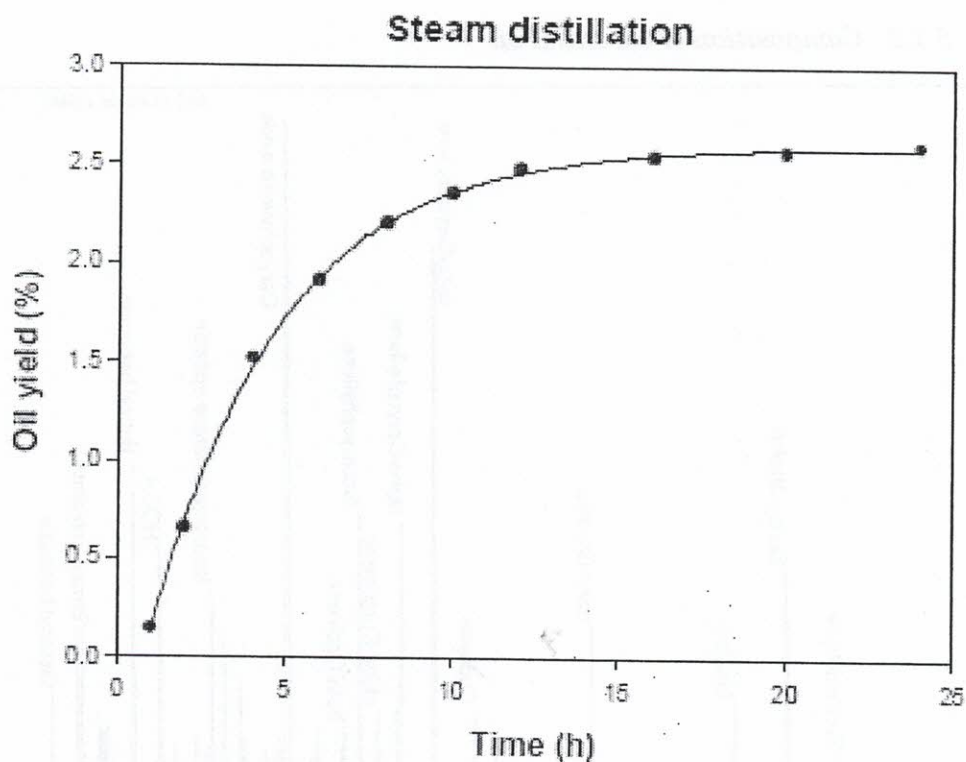
As the number of pressure drop (i.e. number of DIC® cycle) increases, especially when high-pressure steam applied, the alveolation becomes more prominent (formation of wide, deep and interconnected-pores) and results in a higher breaking rate of cell walls. Such complex micro-alveolation structure allows auto-vaporization and liberation of imprisoned compounds within endogenous site in the following pressure drop.

Beside of the processing parameters, the internal structure modification depends also on the nature of flowers (physical, thermal stability, moisture content, etc).

A great advantage of the DIC® method is its rapidity. The results of a comparative study of extraction kinetics of the steam distillation and the DIC® process (6 bar and 8 cycles) are shown in Fig. 6. In case of DIC® process, the increase of oil yield is considerable during the first 4 minutes. In contrast, the steam distillation required 12 h for isolating of 95% of essential oil. The yield of the DIC® with of 8 cycles during a total processing time of 4 min (2.74%) at 6 bar was comparable to that obtained after 24 h by means of steam distillation (2.60%), which is the reference method in essential oil extraction. These results confirm a substantial saving of time, energy and plant material by using the DIC® process. In conclusion, the process parameters of 6 bar, 8 cycles and 4 min can be regarded as optimum for Indonesian ylang oil extraction.



(a)



(b)

Figure 6 : Comparison of kinetics extraction between DIC® at 6 bar, 8 cycles (a) and steam distillation (b)

Beside of the quantity aspect, the performance of an extraction method is appreciated according to high quality of oil produced. For this purpose, a comparison of chemical composition of ylang oil obtained by DIC® and steam distillation methods was made. The results are summarized in next chapter.

5.1.2. Composition of essential oil

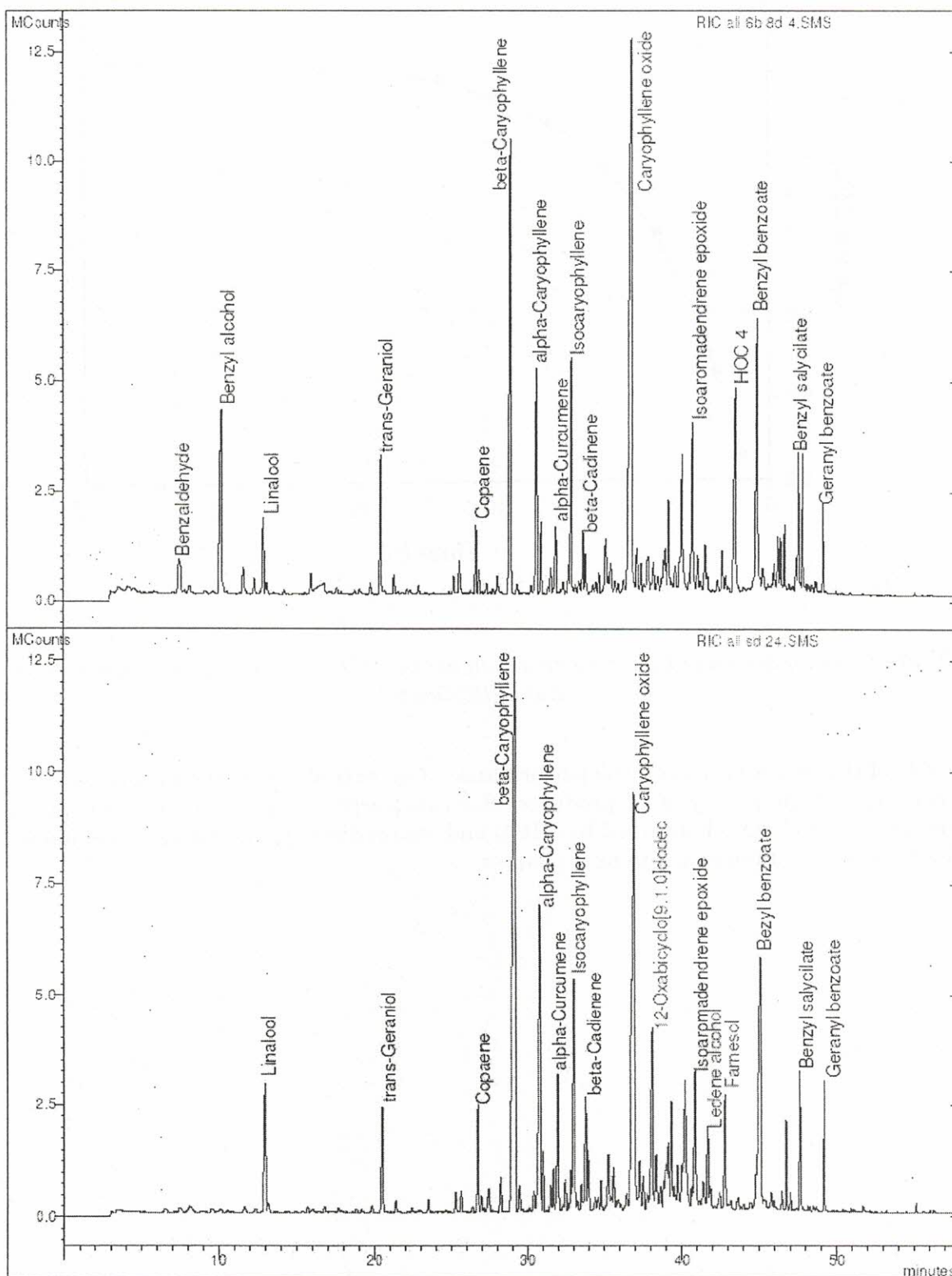


Figure 7 : Comparison of gas chromatograms of Indonesian ylang-ylang oil obtained by DIC® at 6 bar, 8 cycles, 4 min (above) and SD during 24 h (below)

Table 1. The chemical composition of Indonesian ylang-ylang oil obtained by SD and DIC®

No	Retention time (min)	Compounds	Type	Steam distillation 24 h	DIC® 6 bar, 8 cycles, 4 min
1	7.682	Benzaldehyde	LOC	0.13%	1.21%
2	8.151	5-Hepten-2-one	LOC	0.24%	0.24%
3	10.13	Benzyl Alcohol	LOC	0.08%	5.51%
4	11.652	cis-Linalool Oxide	LOC	0.12%	0.58%
5	12.385	trans-Linalool Oxide	LOC	0.06%	0.28%
6	13.029	Linalool	LOC	2.26%	1.40%
7	13.186	3-Octyne-2-one	LOC	0.15%	0.20%
8	16.038	Benzyl acetate	LOC	0.08%	0.30%
9	19.855	beta-Citral	LOC	0.00%	0.13%
10	20.53	trans-Geraniol	LOC	1.56%	2.40%
11	21.391	Geranial	LOC	0.13%	0.28%
12	25.281	alpha.-Cubebene	S	0.23%	0.24%
13	25.64	Eugenol	LOC	0.26%	0.55%
14	26.763	Copaene	S	1.32%	1.01%
15	26.969	Geranyl acetate	LOC	0.23%	0.31%
16	28.255	Methyl eugenol	LOC	0.53%	0.38%
17	27.356	beta-Cubebene	S	0.21%	0.17%
18	27.463	(-)-beta-Elementene	S	0.33%	0.00%
19	29.218	beta-Caryophyllene	S	18.20%	9.85%
20	29.468	Bicyclo[4.4.0]dec-1-ene	S	0.38%	0.18%
21	30.394	n.i.	S	0.35%	0.14%
22	30.852	alpha.-Caryophyllene	S	6.52%	3.82%
23	31.035	alpha-Curcumene	S	0.71%	0.92%
24	31.509	Epizonarene	S	0.30%	0.10%
25	31.675	gamma-Murolene	S	0.53%	0.37%
26	31.961	1H-Cyclopenta[1,3cyclopropa[1,2]	S	2.05%	1.15%
27	32.466	(+)-Epi-bicyclosquiphellandrene	S	0.42%	0.21%
28	32.834	alpha-Murolene	S	0.59%	0.45%
29	33.068	Isocaryophyllene	S	4.25%	3.80%
30	33.08	alpha.-Farnesene	S	-	0.03%
31	33.279	beta-Bisabolene	S	0.09%	0.10%
32	33.517	gamma-Cadinene	S	0.32%	0.15%
33	33.804	beta-Cadinene	S	1.51%	1.00%
34	33.948	Calamene + delta-Cadinene	S	0.91%	0.75%
35	34.41	Naphthalene,1,2,3,4,4a,7-hexahydro-	S	0.17%	0.11%
36	34.827	Cadala-1(10),3,8-triene	S	0.37%	0.30%
37	35.274	n.i.	HOC	1.07%	1.07%
38	35.629	Longipinocarveol trans	HOC	0.61%	0.64%
39	35.81	9-Methoxycalamenene	HOC	0.15%	0.19%
40	36.043	n.i.	HOC	0.09%	0.13%
41	36.477	3-Hexen-1-ol	HOC	0.37%	0.28%
42	36.955	Caryophyllene oxide	HOC	13.75%	20.14%
43	37.263	Aristolenene epoxide	HOC	0.82%	0.65%
44	37.546	n.i.	HOC	0.46%	0.40%
45	38.143	12-Oxabicyclo[9.1.0]dodeca-3,7-diene	HOC	4.01%	1.17%
46	38.367	Tricyclo[5.2.2.0(1,6)]undecan-3-ol	HOC	1.00%	0.62%
47	38.852	Cubenol	HOC	0.40%	0.29%
48	39.027	Aromadendrene oxide-(1)	HOC	0.91%	0.51%
49	39.15	Aromadendrene oxide-(2)	HOC	1.07%	0.83%

No	Retention time (min)	Compounds	Type	Steam distillation 24 h	DIC® 6.10 ⁵ Pa 8 cycles, 4 min
50	39.359	Tetracyclo[6.3.2.0(2,5).0(1,8)tridecan-	HOC	1.63%	1.64%
51	39.762	Ledene oxide-(II)	HOC	0.72%	0.54%
52	40.043	Cedrenol	HOC	0.77%	0.73%
53	40.221	n.i.	HOC	2.44%	2.51%
54	40.324	Cycloisolongifolene,8-hydroxy-,endo-	HOC	0.73%	0.57%
55	40.916	Isoaromadendrene epoxide	HOC	2.72%	3.37%
56	41.706	Ledene alcohol	HOC	1.30%	0.88%
57	42.835	(E,E)-Farnesol	HOC	1.85%	0.73%
58	43.564	n.i.	HOC	0.07%	4.97%
59	45.092	Benzyl benzoate	HOC	7.87%	6.52%
60	45.945	n.i.	HOC	0.09%	0.24%
61	46.461	n.i.	HOC	0.16%	0.57%
62	46.73	n.i.	HOC	0.81%	0.60%
63	47.442	Platambin	HOC	0.02%	0.41%
64	47.617	Benzyl salicylate	HOC	1.49%	1.63%
65	47.768	4,4,8-Trimethyltricyclo[6.3.1.0(1,5)]	HOC	0.02%	1.28%
66	48.657	Oxacycloheptadecan-2-one	HOC	0.04%	0.10%
67	49.202	Geranyl benzoate	HOC	0.77%	0.61%

LOC: Light oxygenated compounds; S: Sesquiterpenes; HOC: Heavy Oxygenated Compounds

n.i.: non-identified

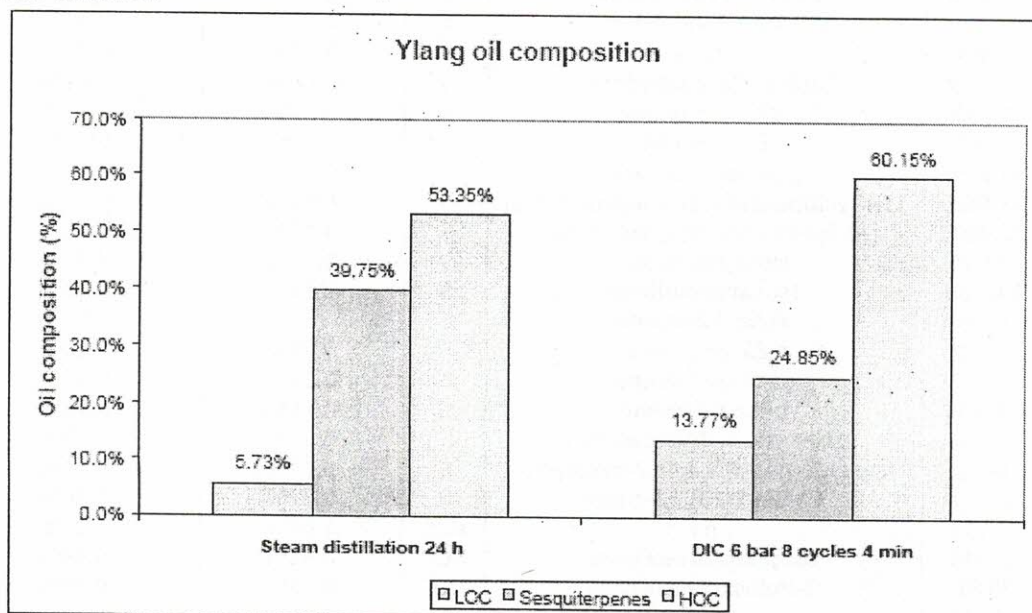


Figure 8 : Comparative chemical composition of Indonesian ylang oil obtained by steam distillation during 24 h and DIC® at 6 bars with 8 cycles in 4 min

The gas chromatograms of ylang-ylang oil obtained from dried flowers by DIC® and SD techniques are shown in Fig. 7. The chemical composition of these oils is presented in Table 1. From 67 peaks 58 components were identified, which constitute more than 90% of the volatile fraction.

The components were grouped into compound families in order to better appreciate the effect of extraction method on the chemical composition of isolated oils (see Fig. 8). In this figure, it can be seen that a substantially higher amount of oxygenated compounds and a lower amount of sesquiterpenes hydrocarbons are present in the

ylang oil extracted by DIC® in comparison with the steam distillation.

Value of ylang-ylang oils is determined by the content of oxygenated constituents and sesquiterpenes. The quality of ylang-ylang oil increases with the content of both light and heavy oxygenated compounds. The sesquiterpenic portion gives no more than a weak contribution to the typical ylang-ylang odour. As it is insoluble in alcohol, fine perfumery seeks the oils which are rich in oxygenated constituents. The sesquiterpenic oils are used in soap manufacture. According to Buccellato [26], the oxygenated compounds (alcohols, esters, ethers, phenols and aldehydes) provide the medicinal, floral, spicy/balsamic and fruity note to the odour profile, whereas the sesquiterpenes contribute to the woody character only in ylang odour.

It appears that the DIC® process provided better quality of ylang oil than the steam distillation.

A lower content of sesquiterpenes in the DIC® oil is probably due to the diminution of thermal degradation. The steam distillation uses a large quantity of water at a high temperature for a long time. Water is a polar solvent, which accelerates many reactions, especially via carbocation as intermediates. This results in hydrolytic, trans-esterification or oxidation reactions of the other compounds into sesquiterpenes.

The HOC and sesquiterpenes are the main components in the Indonesian ylang oil but their relative amounts differ according the extraction methods (see Table 1 and Fig. 8).

5.2. Analysis of residual flowers

For better understanding of the DIC® extraction mechanism, a quantitative comparative study of the residual and reference extract (control) was realized. These extracts were obtained by extraction of the DIC® treated and untreated flowers with chloroform during 6 h. The effects of DIC® parameters on the global yield and the availability of grouped compounds in flowers were examined. To prove the mechanical effect of DIC® treatment, the scanning electron microscopy of untreated and DIC® treated flowers was realized.

5.2.1. Concrete yield of DIC® treated flowers

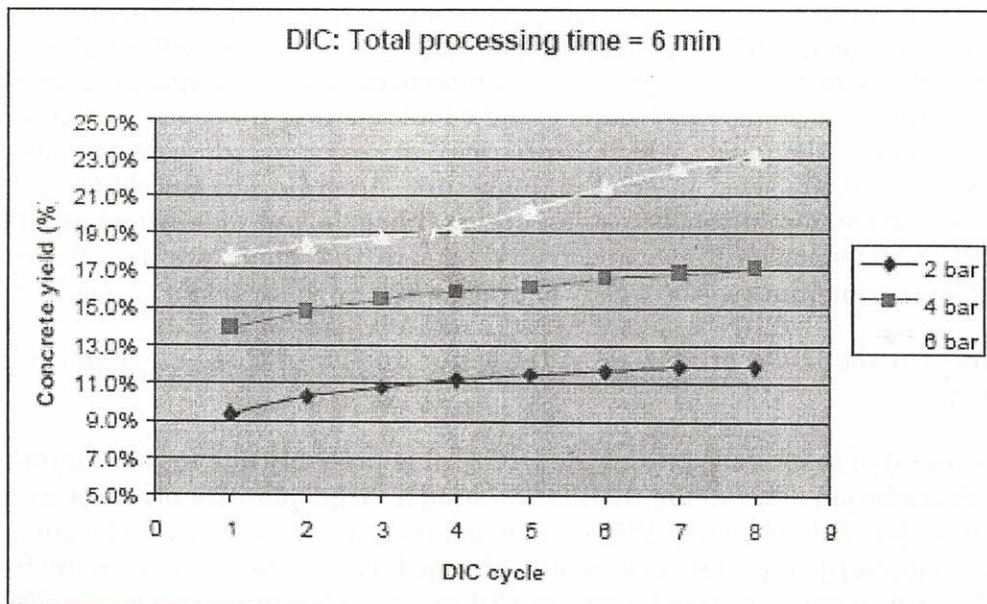


Figure 9 : Effect of DIC® cycle and processing pressure on concrete yield

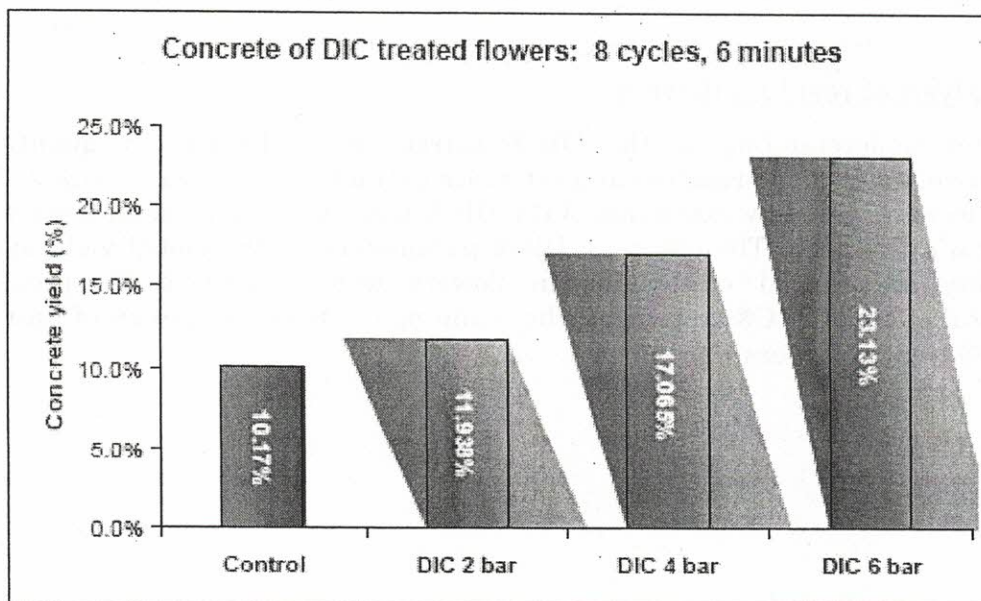


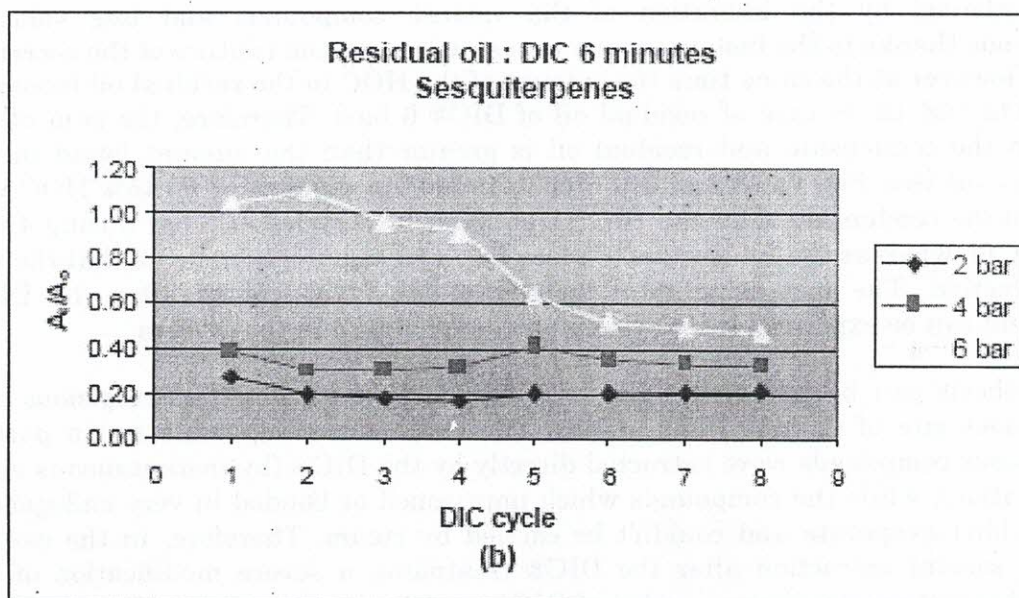
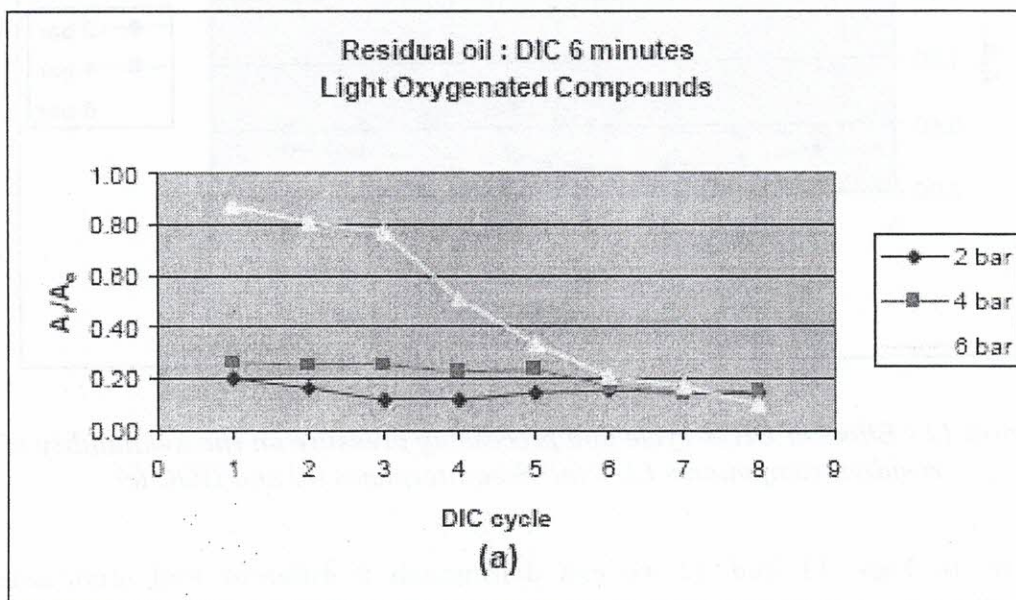
Figure 10 : Comparative concrete yield obtained by solvent extraction of untreated and DIC® treated flowers

Figure 9 shows the concrete yield of DIC® treated flowers increase with increasing processing pressure and number of cycle.

Figure 10 shows a positive effect of the DIC® treatment on the augmentation of availability of non-volatile molecules. Concrete that obtained by solvent extraction consists of volatile oil and non-volatile molecules such as resin, wax, pigment, fatty

oil, etc. The flowers treated by DIC® at high pressure and several cycle undergo severe modification of internal structure. This new structure improve the mass transfer in solvent extraction, thus the global yield raise two-times than that of untreated flowers (23.13% vs. 10.17%), in case of DIC® at 6 bar.

5.2.2. Availability of compounds in DIC® treated flowers



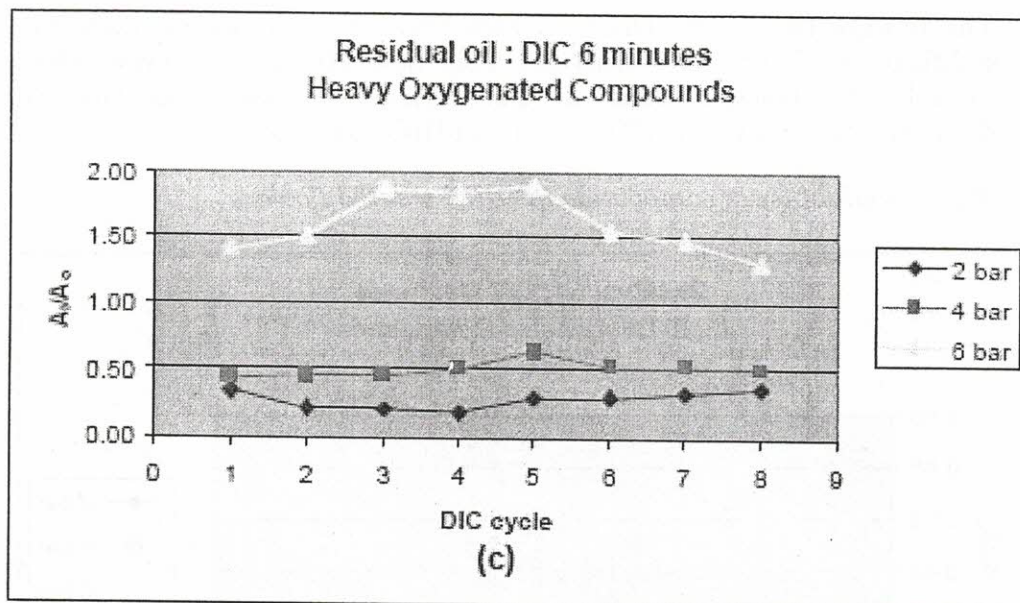


Figure 11 : Effect of DIC® cycle and processing pressure on the availability of residual compounds: LOC (a), Sesquiterpenes (b) and HOC (c)

According to Figs. 11 and 12 we can distinguish 2 different and simultaneous phenomena:

There is extraction of the LOC, sesquiterpenes and a part of the HOC by the DIC. It was explained by the liberation of the volatile compounds and less volatiles compounds thanks to the instantaneous vaporization and the rupture of the secreting walls. However at the same time the amount of the HOC in the residual oil increases (Figs. 11c and 12, in case of residual oil of DIC® 6 bar). Therefore, the sum of the HOC in the condensate and residual oil is greater than the amount found in the reference oil (see Fig. 6a, 8 and 12). For example, an amount of 60.15% HOC was found in the condensate after the DIC® treatment by 8 cycles at 6 bar during 4 min (see Fig. 8), whereas the A_i/A_0 value > 1 (see Fig. 11c) seemingly indicate that there is no extraction. The increasing total amount of the HOC gained after the DIC® treatment can be explained by the rising of its availability in the flowers.

A hypothesis can be made that the HOC are located both in the exogenous and endogenous site of oil-containing glands. The exogenous compounds and a part of endogenous compounds were extracted directly by the DIC® (by instantaneous auto-vaporization), while the compounds which imprisoned or bonded in very endogenous site couldn't evaporate and couldn't be carried by steam. Therefore, in the case of organic solvent extraction after the DIC® treatment, a severe modification of the internal structure (by several cycles of DIC® at 6 bar) will increase the number of cells accessible for the solvent.

The behaviour of LOC and Sesquiterpenes availability in flowers treated by DIC® at 6 bar is very interesting (see Figs. 11a and 11b). At the first cycle, theirs availability is very high compared to that of 2 and 4 bar then drop drastically with increasing of DIC® cycle until the availability at last cycle similar to that of 2 bar. In contrast, at 2 and 4 bar, the availability of residual LOC and Sesquiterpenes varied slightly with the number of cycle. These facts proved our hypothesis in previous chapter that the

extraction mechanism is based also on the autovaporization from the modified structure.

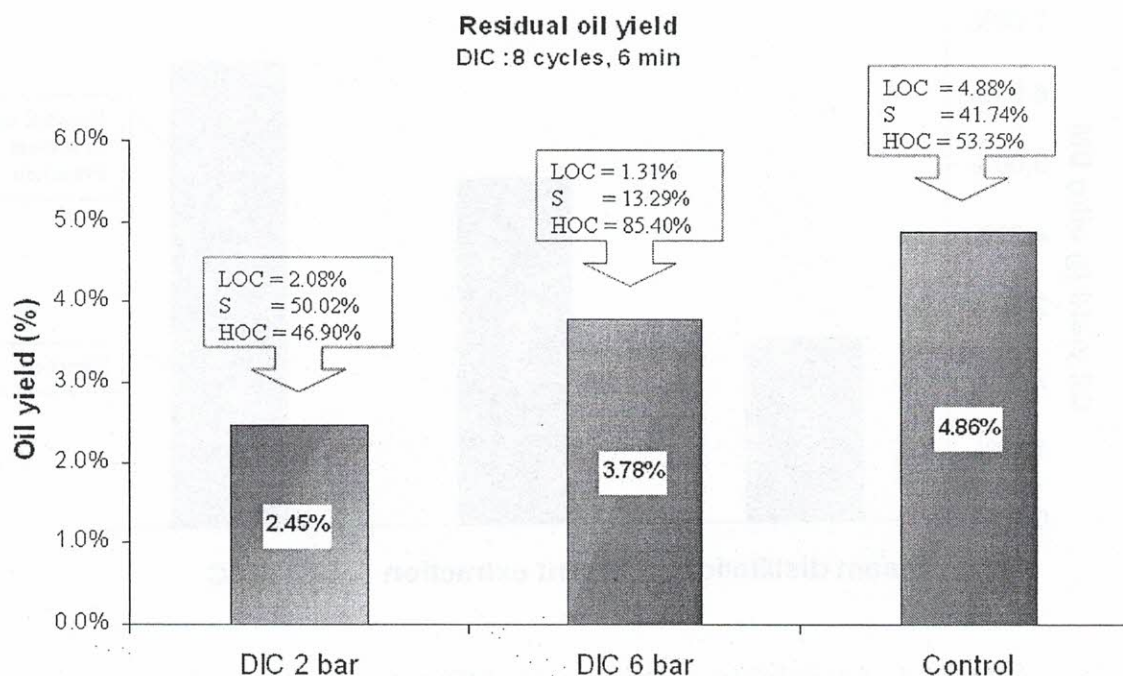


Figure 12 : Comparative yield and composition of oil obtained by solvent extraction of untreated and DIC® treated flowers

From Fig. 12, it is interesting to note that the residual oil (6 bar, 8 cycles, 6 min) had a low content of the LOC and Sesquiterpenes compared to the reference oil. In contrast, this residual oil was very rich in the HOC. These results proved the hypothesis about 2 simultaneous phenomena in DIC® extraction which was described above.

The availability of ylang-ylang oil by different extraction techniques can be seen in Fig. 13.

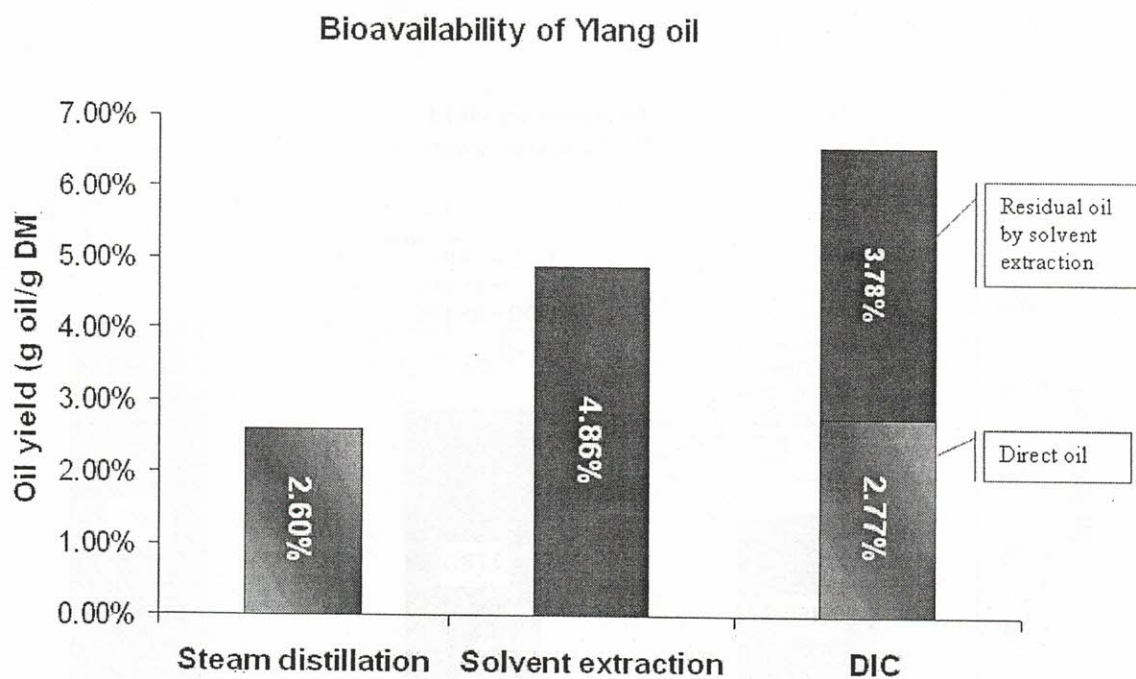


Figure 13 : Availability of Ylang oil by different extraction techniques

The availability of ylang oil in classical extraction methods is lower than that by using the DIC® treatment. The classical methods don't allow getting the total isolation of the essential oil. A similar increase of the flavanoids availability in apples and onion by the DIC® treatment was found by El Rifai et al. [27].

5.2.3. Scanning electron microscopy

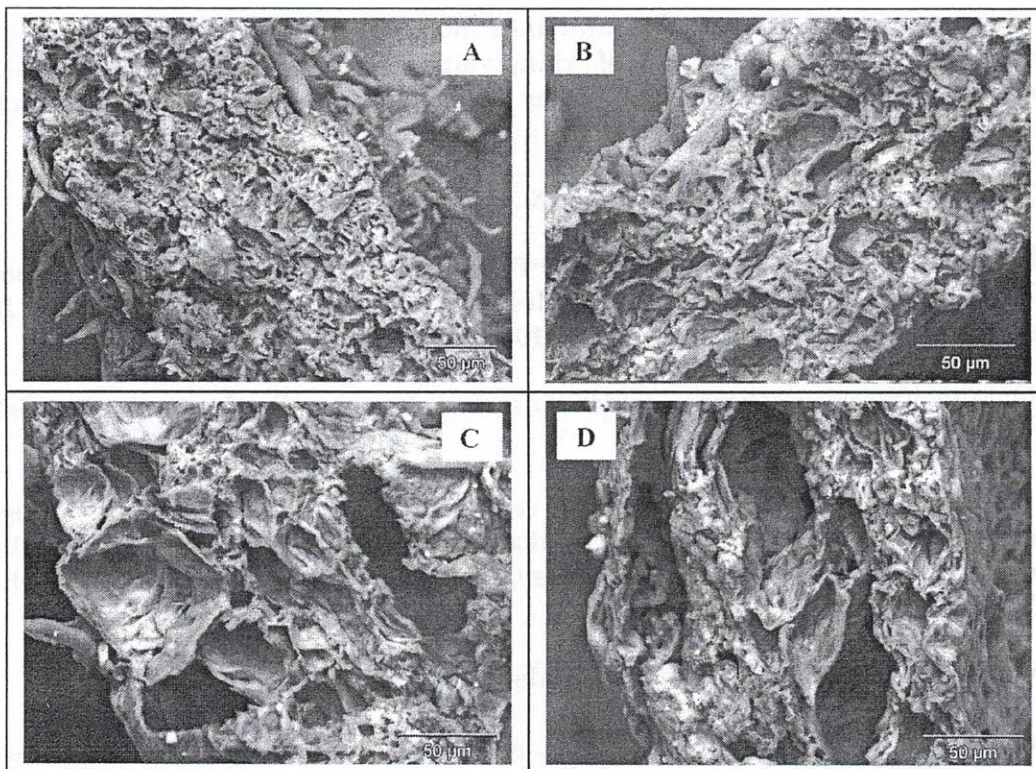


Figure 14 : Scanning electron micrographs of untreated flowers (A) and DIC® treated flowers at 2 bar, 1 cycle, 10 min. (B), 6 bar, 5 cycles, 4.4 min. (C), and 6 bar, 9 cycles, 10 min. (D).

Micrographs of the cross sections of untreated and DIC® treated flowers are shown in Fig. 14. These micrographs proved the aptitude of DIC® on the modification of internal structure.

The higher the processing pressure and the more the DIC® cycles, the higher the degree of alveolation which results in a higher breaking rate of cells walls. This facilitates liberation and vaporization of volatile and less volatile molecules (the LOC, Sesquiterpenes and HOC) and provides the availability of the residual HOC for solvent extraction from the endogenous site of glands.

6. Conclusion

The essential oil extraction from ylang flowers is very efficient by using the DIC® process. The optimum oil yield (2.74%) is obtained with eight cycles at a steam pressure of 6 bar and total processing time of 4 min. In comparison with the steam distillation, the DIC® oil contains higher content of light and heavy oxygenated components. In contrast, its sesquiterpenes content is lower. The DIC® treatment increases the availability of the heavy oxygenated components in the flowers. The structure of the flowers is more alveolated at the higher pressure and number of DIC® cycle. The DIC® can be also used as a pretreatment technique for the improvement of the solvent extraction or others conventional extraction techniques of non-volatiles compounds.

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- Preparation, implementation & monitoring-evaluation of development-oriented agricultural & environmental research and training projects; strategic planning of research activities.

Research & teaching experience:

- Current main research interest: improvement of transitional agricultural production systems in the sloping uplands of northern Thailand and the drought-prone rainfed areas of northeastern Thailand: use of the companion modeling approach and multiagent systems to examine resource management problems, for collective exploration of possible future scenarios, and to design action plans with all concerned stakeholders in the regional context of decentralization of natural resource management.
- Diagnostic and participatory analyses of the transformations and functioning of regional (sub-national) agrarian systems, implications for agricultural research, development and environmental management.
- Stakeholder analysis and field research on the differentiation of livelihood and farming systems at the regional (sub-national) level to improve agricultural research, resource management, and development interventions.
- Design, field testing & dissemination of innovative (indigenous & introduced) production systems to improve resource management and the environment.
- On-farm research and development-oriented field research activities on a wide range of agricultural production systems in Southeast Asia since 1981.
- Lecturer at various universities and institutions of higher education: INAP-G in Paris, IEDES-Paris, Paris X University, CNEARC-Montpellier, ESA-Toulouse in France; Asian Institute of Technology, Chulalongkorn and Kasetsart Universities in Bangkok, Chiang Mai, Maejo, Khon Kaen, Ubon Ratchathani Universities in Thailand, University of the Philippines, IRRI Training Center at Los Baños, etc.

- Adviser of M.Sc. & Ph.D. Asian and French students in the fields of systems agronomy, natural resource management, and human geography.

Languages:

- Native: French
- Other working languages: English, Thai
- Others: Spanish, Lao

Awards & Nominations:

- 1987: «Chevalier de l'Ordre du Mérite Agricole », Ministry of Agriculture, Paris, France.
- 2001: Visiting faculty, post-graduate training program on systems approaches in Agriculture, Faculty of Agriculture, Khon Kaen University, Thailand.
- 2004: Adviser, Ph.D. Program in Agricultural Technology, Faculty of Science, Chulalongkorn University, Bangkok, Thailand.

Professional associations:

- European member of the board of editors, journal of the International Farming Systems Association (IFSA)
- Founding member & country representative of the "Asian Farming Systems Association" (AFSA)
- European Association for South-East Asian Studies (EUROSEAS)
- Association Française pour la Recherche sur l'Asie du Sud-Est (AFRASE).
- Founding member of the inter-institutional & international Companion Modelling (ComMod) network, France.

Selected publications:

- TREBUIL G., EKASINGH B., and M. EKASINGH. 2005. Agricultural Commercialisation, Diversification, and Conservation of Renewable Resources in Northern Thailand Highlands. In: Moussons Journal, France (Forthcoming).
- LE COQ J.F., and G. TREBUIL. Impact of Economic Liberalization, Rice Intensification, and Agricultural Diversification, on Rural Livelihood Systems of the Mekong Delta, Vietnam. In: Southeast Asian Studies, Kyoto University, Japan. Accepted.
- BARNAUD C., TREBUIL G., DUFUMIER M., N. SUPHANCHAIMART. 2005. Rural Poverty and Diversification of Farming Systems in Upper Northeast Thailand. In: Moussons, France (Forthcoming).
- BOUSQUET F., TREBUIL G., BOISSAU S., BARON C., D'AQUINO P. and J.C. CASTELLA. 2005. Knowledge Integration for Participatory Land Management: The use of multi-agent simulations and a companion modelling approach. In: Participatory Technology Development & Local Knowledge for Sustainable Land Use in Southeast Asia, White Lotus Editions, Bangkok, Thailand.

- BOUSQUET F., and G. TREBUIL. 2004. Companion Modeling and Multi-Agent Systems for Collective Learning and Resource Management in Asian Rice Ecosystems. Proc. Of the World Rice Research Conference, topic 13: Farmers/participatory approaches, 4-7 November, Tokyo & Tsukuba, Japan.
- LE COQ J.F., TREBUIL G., and M. DUFUMIER. 2004. History of rice production in the Mekong delta. In: Boomgaard P. & D. Henley (eds). Smallholders and stockbreeders: Histories of food crop & livestock farming in Southeast Asia, KITLV Verhandeligen series, Leiden, The Netherlands & ISEAS, Singapore. 163-185.
- TREBUIL G. and M. HOSSAIN. 2004. Le riz: enjeux écologiques et économiques [Rice: ecological and economic challenges]. Collection Mappemonde, Belin Editions, Paris. 265p.
- TREBUIL G., and F. BOUSQUET. 2003. Interdisciplinary Training on Multi-Agent Systems, Social Sciences and Integrated Natural Resource Management in Thailand: Preliminary lessons from an inter-university project. Proc. international conference Grad Blueprint 2003: Multidisciplinary programs, management for future Graduate Studies, 7-9 May 2003, The Graduate School, Chulalongkorn University, Bangkok, Thailand. Electronic document: <http://www.grad.chula.ac.th>
- KAM S.P., CASTELLA J.C., HOANH C.T., TREBUIL G. and F. BOUSQUET. 2002. Methodological integration for sustainable natural resource management beyond field/farm level: lessons from the ecoregional initiative for the humid and sub-humid tropics of Asia. In: International Journal of Sustainable Development and World Ecology, 9:383-395. - TREBUIL G., SHINAWATRA-EKASINGH B., BOUSQUET F., and C. THONG-NGAM. 2002. Multi-Agent Systems Companion Modeling for Integrated Watershed Management: A Northern Thailand Experience. In: Landscapes of diversity, X. Jianchu and S. Mikesell (eds), Yunnan Science and Technology Press, China. 349-358.
- TREBUIL G. and S. THUNGWA, 2002. Farmers' direct-sowing practices in rainfed lowland rice in southern Thailand: improving a traditional system. In: Pandey S, Mortimer M, Wade L, Tuong TP, et al. (eds). Direct Seeding: research issues and opportunities. International Rice Research Institute, Los Baños, Laguna, Philippines. 99-114.
- MALEZIEUX E., TREBUIL G. and M. JAEGER, 2001. Modéliser les agroécosystèmes [Agroecosystem Modelling]. In: Modélisation des agroécosystèmes et aide à la décision, Malézieux E, Trebil G. and M. Jaeger (eds). Collection Reperes, Cirad-INRA, Montpellier, France. 17-33.
- KAM S.P., HOANH C.T., TREBUIL G., and B. HARDY (eds), 2001. Natural Resource Management Issues in the Khorat Basin of Northeast Thailand: An Overview. International Rice Research Institute, Limited Proceedings n°7, Los Baños, The Philippines, 169p.
- TREBUIL G. et M. HOSSAIN. 2000. Les grands types de rizicultures en Asie du Sud-Est: Transformations récentes, enjeux actuels et perspectives d'évolution [Main types of rice production systems in Southeast Asia : recent transformations, current challenges and perspectives]. In: Revue Tiers Monde, Presses universitaires de France, IEDES, Université Panthéon-Sorbonne, Paris, XLI/162:277-299.

- TREBUIL G., THONG-NGAM C., TURKELBOOM F., GRELLET G. and S.P. KAM. 2000. Trends of land use change and interpretation of impacts in the Mae Chan area of northern Thailand. Proceedings of the International Symposium II on Montane Mainland Southeast Asia: Governance in the Natural and Cultural Landscape, 1-5 July 2000, Chiang Mai, Thailand.
- TREBUIL G., VAN KEER K. and E. GOZE, 2000. Identifying and grading limiting factors of upland rice yields in farmers' fields of northern Thailand. International Rice Research Notes, IRRI, 25/1:31-33.
- HARNPICHITVITAYA D., TREBUIL G., PANTUWAN G., I. CRAIG, TUONG T.P., WADE L.J. and D. SURIYA-ARUNROJ, 2000. Identifying soil suitability for subsoil compaction to improve water- and nutrient-use efficiency in rainfed lowland rice. In: Characterizing and Understanding Rainfed Environments, Tuong TP, Kam SP, Pandey S, Bouman BAM (eds). International Rice Research Institute, Los Baños, Philippines. 97-110.
- MANICHON H. and G. TREBUIL, 1999. An ecoregional approach for development oriented research on agricultural systems. In: Towards an Ecoregional Approach for Natural Resource Management in the Red River Basin of Vietnam, N.N. Kinh, P.S. Teng, C.T. Hoanh and J.C. Castella (eds); Ministry of Agriculture & Rural Development, Hanoi, Vietnam. 13-28.
- CASTELLA J.C., JOURDAIN D., TREBUIL G. and B. NAPOMPETH, 1999. A systems approach to understand obstacles to effective implementation of IPM in Thailand: key issues for the cotton industry. In: Agriculture, Ecosystems and Environment, 72:17-34. - TREBUIL G., HARNPICHITVITAYA D., TUONG T.P., PANTUWAN G., L.J. WADE and S. WONPRASAID, 1998. Improved water conservation and nutrient-use efficiency via subsoil compaction and mineral fertilization. In: Ladha JK, Wade LJ, Dobermann A, Reichardt W, et al. (eds). Rainfed Lowland Rice: Advances in Nutrient Management Research. International Rice Research Institute, Philippines. 245-256.
- TURKELBOOM F. and G. TREBUIL, 1998. A Multiscale Approach for On-farm Erosion Research: Application to Northern Thailand Highlands. In: Soil Erosion at Multiple Scales: Principles and Methods for Assessing Causes and Impacts. Penning de Vries, Frits W.T, Fahmuddin Agus and John Kerr (eds). CABI and IBSRAM. 51-71.
- VAN KEER K., TREBUIL G. and B. COURTOIS, 1998. On-farm Characterization of Upland Rice Varieties in North Thailand. In: International Rice Research Notes, IRRI, Los Banos, Laguna, Philippines. 23/3:21-22.
- CASTELLA J.C., TREBUIL G. and Y. CROZAT. 1997. Diagnosis on Thai Agrarian Systems for Research Prioritization to Improve the Sustainability and Competitiveness of Cotton Production. In: The Kasetsart Journal (Natural Sciences), 31/5:1-15.
- TREBUIL G., KAM S.P., TURKELBOOM F. and B. SHINAWATRA, 1997. Systems Diagnoses at Field, Farm and Watershed Levels in Diversifying Upland Agroecosystems: Towards Comprehensive Solutions to Farmers' Problems. In: P.S. Teng et al. (eds). Systems Approaches for Sustainable Agricultural Development: Applications of Systems Approaches at the Farm and Regional Levels. Kluwer Academic Publishers & IRRI, UK. 99-114.

- THONG-NGAM C., SHINAWATRA B., HEALY S. and G. TREBUIL, 1997. Resources Management and Decision-Making in the Thai Highlands. In: *Journal of Contemporary Asia*, 27/2:179-197.
- TURKELBOOM F., TREBUIL G. and C. VEJPAS, 1996. Starting from the farmers' fields: On-farm analysis and development of conservation strategies on steep lands. In: *Soil Conservation Extension: from Concepts to Adoption*. Sombatpanit S., Zobisch M.A., Sanders D.W. & M.G. Cook (eds), Bangkok, Thailand. 141-152.
- TREBUIL G., 1996. Farmer differentiation in southern and central Thai agrarian systems: Who benefits from agricultural growth? In: *Uneven Development in Thailand*; Mike Parnwell, Centre for Southeast Asian Studies, University of Hull (ed.), Avebury Press, Aldershot, UK. 241-264.
- TREBUIL G., 1995. Pioneer Agriculture, Green Revolution and Environmental Degradation in Thailand. In: *Counting the costs: economic growth and environmental change in Thailand*; Jonathan Rigg, University of Durham (ed.), Institute of Southeast Asian Studies (ISEAS), environment & development series, Singapore. 67-89.
- TREBUIL G., 1995. Télédétection et système agraire en Thaïlande occidentale [Remote sensing and the agrarian system of the western region of Thailand]. In: *Agriculture et développement*, 5:4-15.
- TREBUIL G., 1994. Cotton production in Laos. In: *Agriculture et développement*, 1:4-13. - TREBUIL G., KAOJARERN S., TRAIMONGKONKOOOL P., NGERNPRASERTSRI N. and J.C. CASTELLA, 1994. Dynamics of Agrarian Landscapes in Western Thailand: Hypotheses to improve the sustainability of farming systems. DORAS Project, Kasetsart University & Asian Institute of Technology, Bangkok, Thailand, 58p.
- TREBUIL G. and M. DUFUMIER, 1993. Regional agrarian systems and sustainability of agricultural production systems in Thailand. In: *Journal of Asian Farming Systems Association*, 1/4:557-568.
- TREBUIL G., 1993. Agriculture pionnière, révolution verte et dégradation de l'environnement en Thaïlande: le cinquième dragon ne sera pas vert [Pioneer agriculture, green revolution and environmental degradation in Thailand : the 5th dragon will not be green]. In: *Tiers-Monde*, Presses universitaires de France et IEDES, Université Panthéon Sorbonne, Paris. 134:365-383.
- TREBUIL G., 1991. La Thaïlande : un nouveau pays agro-industriel [Thailand : a new agro-industrial country]. In: *Problèmes Economiques*, La Documentation Française, Paris. 2215:29-31.
- TREBUIL G. (ed.) 1988. Farming Systems Research and Development in Thailand: Illustrated Methodological Considerations and Recent Advances. GRET, Paris and Prince of Songkla University, Hat Yai, Thailand. Re-edited in 1990 at Kasetsart University, Bangkok, Thailand. 212p.

KARIM ALLAF

Born on February 15, 1952, in Tripoli (Lebanon).

Nationality:

Present: French.

Birth: Lebanese.

Married with three children (34, 22 and 21 years).

STUDIES AND ACADEMIC DIPLOMAS:

- 1973 Master Sc. of Physics. Faculty of Science - Lebanese University
- 1974 D. E. A. (Atomic and molecular physics – non-linear Optic); Institute of non-linear Optic; University of Paris XI - Orsay
- 1976 Doctorat 3rd cycle (*Physics of low temperature Plasmas - Mention very honorable*) Laboratory of Gases and Plasmas. C. N. R. S., University of Paris XI - Orsay.
- 1981 Doctorat d'Etat – Ph'D (*Thermodynamics, Chemical Engineering. Mention very honorable*) Chemistry Polytechnic National Institute INP - Toulouse.
Laboratory of Ultra-Refractory material CNRS Solar Centre
66120 ODEILLO

ACADEMIC AND ADMINISTRATIVE FUNCTIONS:

- 1973/1981 Researcher from the LEBANESE UNIVERSITY to the French CNRS.
- 1981/1988 Associated Professor, Professor, Director of Department of Physics – Faculty of Science – LEBANESE UNIVERSITY.
- 1988/1994 Associated Professor, Professor Co-animator *then* Animator of The Division Agro-industrial Technologies DTAI- Department of Chemical Engineering of the UNIVERSITY OF TECHNOLOGY OF COMPIEGNE

UNIVERSITY OF LA ROCHELLE

Since 1994 Professor, director of the Laboratory Mastering of Agro-Industrial technologies LMTAI (Ministerial Research Team UPRES JE 2002 then EA 3166) ; Director of Industrial Process Engineering; Director of IUP GEPI (Industrial Equipment and Processes) Pole Science & Technology - LA ROCHELLE UNIVERSITY

INTERNATIONAL RESPONSIBILITIES:

- Since 1984 Member of the Third World Academy of Sciences TWAS
- Since 1987 Associated Member to the ICTP (International Agency of Nuclear Energy; International Centre of Theoretical Physics I.C.T.P. - U.N.E.S.C.O) Trieste - Italy.

- | | |
|--------------------|---|
| <i>1993/2000</i> | Member of the piloting committee and President of the Scientific Commission of the European project THERMIE. |
| <i>1994/1996</i> | Member of the piloting committee and President of the Scientific Commission of the European project CRAFT WEST. |
| <i>1997/2001</i> | Coordinator and President of the piloting committee and the scientific commission of the European project INNOVATION. |
| <i>depuis 2001</i> | Coordinator and President of the piloting committee and the scientific commission of the European project INNOVATION & SME (DIC'Extract). |

PUBLICATIONS:

PATENTS & EXTENSIONS: 7 Patents and 5 extensions; seven of them concerning the DIC technology (Instantaneous Controlled Pressure Drop: Détente Instantanée Contrôlée).

PUBLICATIONS WITH LECTURE COMMITTEE: 116

INTERNATIONAL CONFERENCES: 38 Twenty of them as International Invited Conferences.

VARIOUS INDUSTRIAL REPORTS: 34

DIRECTION OF PH'D WORKS:

Direction of Doctorates (defended Ph'D): 21 Ph'D

Present Direction of Doctorates (in preparation Ph'D): 8 Ph'D.

VALORIZATION AND TRANSFER ACTIVITIES:

1. Large activity of collaboration with French, European and international industries.
2. Creation of a Transfer Center of the DIC technology (Instantaneous Controlled Pressure Drop: Détente Instantanée Contrôlée) from the university of The Rochelle: January 1999.
3. Contribution to the creation of three innovative enterprises in France and in Italy.

Duong Thai Cong

1. Family Name: Duong
2. First Name: Cong (Full name: Duong Thai Cong)
3. Date of Birth: June 6, 1958
4. Nationality: Vietnamese
5. Civil Status: Married

6. Education / Professional studies:

Institution:	Cantho University, Vietnam
Date From/To:	1976 - 1980
Degree/Diploma:	Bachelor on Agricultural Mechanical Engineering
Institution:	Wageningen University – The Netherlands.
Date From/To:	1995 - 1997
Degree/Diploma:	Master on the Agricultural Engineering
Institution:	La Rochelle University France
Date From/To:	1998
Degree/Diploma:	Short training (3 months)
Institution:	La Rochelle University, France
Date From/To:	2000 - 2003
Degree/Diploma:	PhD on the process engineering (Parboiling Rice)

7. Language Skills: (Mark from 1 (notions) to 5 (excellent) for competence)
(* = mother tongue)

<u>Language</u>	<u>Speaking</u>	<u>Reading</u>	<u>Writing</u>
English	3	4	3
French	4	4	4

8. Membership of Professional Bodies:

9. Other Skills:

Agricultural Mechanical Engineering
Process Engineering

10. Present Position within the organisation:

Lecturer of CanTho University

Head of Mechanical Department and Vice Dean of College of Technology - CanTho University, Vietnam.

11. Years with the organisation: Since 1981

12. Key Qualifications: (relevant to the project): Good

13. Experience in specific Asian countries / EU countries:

Country: Vietnam

Date: Since 1981

Details: I have worked in Cantho University as a lecturer, researcher and manager.

Country: The Netherlands

Date: 1995-1997

Details: MSc course on the Agricultural Mechanical Engineering

Country: Germany

Date: 1996

Details: Excursion on Agricultural Machinery in Hanover (1week)

Country: France

Date: 1998

Details: Short training on the process engineering

Country: Thailand

Date: December/2000

Details: Conference on the Particle Technology Symposium (1 week).

Country: France

Date: 2000-2003

Details: PhD program in the process engineering

Country: Indonesia

Date: July 2003

Details: Presentation in The Third International Workshop on Drying Technology, Bogor-Indonesia (Asian Region) (1week).

Country: Thailand

Date: Avril 2004

Details: Presentation in The International Workshop on Biomass Waste Renewable Energy (BiWaRE project, Asia-link).

Country: Germany

Date: Avril – May 2006

Details: - Presentation in The International Workshop on Hazardous Industrial Waste Management (1 week)

- Short training on Plasma Nitriding Technology (1 month)

14. Professional Experience Record (relevant to the project):

Date: Since 1981 to now

Location: CanTho University, Vietnam

Organisation: College of Technology, CanTho University

Position: Head of Mechanical Department & Vice Dean of College of Technology, CanTho University

Responsibilities: Lecturer, researcher and manager in the field of engineering.

15. Publications:

- Treatment by vacuum for paddy before soaking in order to increase the possibility of water absorption based on this to improve heat transfer and masse transfer for DIC process (Détente Instantanée Contrôlée) (*Duong Thai Cong 2001, Magazine of Sciences of CanTho university*).

- Parboiling rice by DIC and drying by DDS (Déhydratation de la Détente Suscessive). (*Duong Thai Cong, Prof. Karim Allaf², 2003, 3rd Workshop on Drying Technology in the Asia*).

- Applying of new method of post harvest technology to improve the quality of agricultural product and reducing the production cost. (*Duong Thai Cong et al., Summary record of Conference of Sciences in Angiang province Vietnam, June 2004*).

- Treatment by vacuum for paddy before soaking in order to increase the possibility of water absorption based on this to improve heat transfer and masse transfer for DIC process (Improved) (*Duong Thai Cong , Magazine of Sciences N^o 3- 2004 of CanTho City*).

MOUNIR Sabah

31 years, single, Egyptian

Assistant lecturer at Agriculture faculty
ZAGAZIG University

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Appt. 16, résidence du parc de la francophonie
avenue Jean Monnet
17000 La Rochelle, France

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DIPLOMAS

- 2003-2005 : Ph.D in Agro-industrial engineering process la Rochelle University, France
- 2000-2001 : Master of Sciences and technologies at INA-PG and UTC, France
- 1997: Bachelor of food sciences at ZAGAZIG University, Egypt. Mention very good,
- 1993: BAC Sciences at EL-SADAT school.

SEARCHING ACTIVITIES

- Swell Spray drying by DIC "Controlled Instantaneous Pressure Drop" "skimmed milk, whey proteins, Na-caseinates, cheese powders, another food
- Swell-drying by DIC « Controlled Instantaneous Pressure Drop » of different products "vegetables and fruits pieces"
- Food Freeze drying.

TRAINING

- October 2004-September 2005 : training at ABCAR-DIC process Company
Subject: feasibility and optimization study of swell- drying by DIC of some biological products
- December 2000-September 2001 : Training DEA at INA-PG « Department Science and biologic and food Industries »
Subject: Combined Effect of heat treatment and protein composition of mixtures on yoghurt texture.
- 1998-2000 : MASTER at ZAGAZIG University, Agriculture faculty « Department of food sciences; Laboratory of food industries
Subject: Anti-oxidant and anti-bacterial effect of essential oils in meat products

PUBLICATIONS ET COMMUNICATIONS

- 1- REMEUF.F, MOHAMED.S, SODONI.I, CORRIEU.G. Preliminary observations on the effects of milk fortification and heating on micro structure and physical

properties of stirred yoghurt, International Dairy Journal, Volume 13, Issue 9, 2003, Pages 773-782

- 2- MOHAMED-MOUNIR.S, ALLAF.K. DIC (Instantaneous controlled pressure Drop) as a new process for improving spray drying kinetics and powder quality. 19-21 October 2004, Second international symposium on Spray drying of milk products. Cork, Ireland, poster and oral talking and publishing in proceeding.
- 3- MOHAMED-MOUNIR.S, ALLAF.K. Définition d'une méthode d'atomisation-texturation DIC et caractérisation comparative du lait en poudre. 16 Rencontres d'AGORAL à Nantes, France. Oral talking and publishing in proceeding.
- 4- MOHAMED-MOUNIR.S, EL-RIFAI.M, ALLAF.K. A comparative study of the Controlled Instantaneous Pressure Drop DIC on the physical powder properties of Apple obtained by Drying/Crushing. 16-18 March 2005 à Rennes, France. Oral talking and publishing in proceeding.
- 5- MOHAMED-MOUNIR.S, ALLAF.K. Is it possible to control the texture of powder particles during spray drying? Impact of Instantaneous Controlled Pressure Drop. 13, 14 May 2005, Paris, France. AFSIA 2005, Oral talking and publishing in proceeding.

CONFERENCES INVITES ET FORMATIONS

- 1- ALLAF.K, MOHAMED-MOUNIR.S. Le 14 mars 2003, présentation lors de la Conférence invitée organisée par le CRITT 2ABI de Dijon sur : Les poudres alimentaires : Production et décontamination.
- 2- ALLAF.K, MOHAMED-MOUNIR.S. Le 16-17 mars 2004, séminaire de formation, Paris sur Le séchage de produits thermosensibles.
- 3- ALLAF.K, MOHAMED-MOUNIR.S. Le 29 avril 2004, présentation lors de la Conférence invitée organisée par l'université Lyon 1 sur : Stratégie scientifique dans le secteur de recherche et d'industrialisation en Génie des procédés Agro-Industriels. Application expérimentale au cas de traitement thermo-mécanique des poudres.
- 4- ALLAF.K, MOHAMED-MOUNIR.S. Le 30 avril 2004, présentation lors de la Conférence invitée organisée par le CRITT 2ABI de Dijon sur: Les poudres alimentaires : Production et décontamination.
- 5- ALLAF.K, MOHAMED-MOUNIR.S. Les 13 et 14 janvier 2005, présentation lors de la Conférence invitée organisée par le CRITT 2ABI de Dijon sur: Les poudres alimentaires : Production et décontamination.
- 6- ALLAF.K, MOHAMED-MOUNIR.S. Les 1 et 2 Décembre 2005, présentation lors de la Conférence invitée organisée par le CRITT 2ABI de Dijon sur: Les poudres alimentaires : Production et décontamination.

ACTIVITE D'ENSEIGNEMENT

- 2004 : charge de travaux pratiques : TP du séchage par atomisation pour la licence 3 de l'IUP GEPI de l'université de La Rochelle, France.
- 1998-2000 : charge de travaux pratiques : TP de la technologie d'huiles essentielles et végétales pour Master1 de la faculté d'Agriculture de l'Université de ZAGAZIG, Egypte.
- 1998-2000 : charge de travaux pratiques : TP de Microbiologie alimentaire pour la licence de la faculté d'Agriculture de l'Université de ZAGAZIG, Egypte
- 1998-2000 : charge de travaux pratiques et cours : de la technologie de préservation de produits alimentaires pour la licence de la faculté d'Agriculture de l'Université de ZAGAZIG, Egypte.
- 1998-2000 : charge de travaux pratiques : TP de la technologie de céréales la licence de la faculté d'Agriculture de l'Université de ZAGAZIG, Egypte.
- 1998-2000 : charge de travaux pratiques : TP des principes de la préservation de produits alimentaires pour la 2ème année de la faculté d'Agriculture de l'Université de ZAGAZIG, Egypte.

ENCADREMENT DE STAGIAIRES

Ces stages sont effectués au Laboratoire de Maîtrise des Technologies Agro-Industrielles « LMTAI » de l'Université de la Rochelle :

- 2006 « Janvier- juin » ; AMESSIS Abdellnour ; Stage de Master 2 (M2) de l'IUP GEPI de l'Université de La Rochelle : 1- Etude de la non instantanéité lors la texturation de produits laitiers en poudre par la détente instantanée contrôlée « DIC » sur la qualité totale du produit. 2- faisabilité et optimiser l'opération de fabriquer de fromage en chips.
- 2005 « Avril- juin » ; FOUILLET Jérémy ; Stage de licence 3 de l'IUP GEPI de l'Université de La Rochelle : Etude de l'expansion de granules de caséinates de sodium par la détente Instantanée Contrôlée « DIC ». Impact sur la qualité totale du produit final et proposition d'un procédé d'atomisation trois étages.
- 2005 « Avril- juin » ; TANQUEREL Julien ; Stage de licence 3 de l'IUP GEPI de l'Université de La Rochelle : Etude de l'expansion de granules de protéines sériques par la détente Instantanée Contrôlée « DIC ». Impact sur les qualités divers du produit final et proposition d'un procédé d'atomisation trois étages.
 - 2005 « Avril- juin » ; MANSOURI Khadija ; Stage de licence 3 de l'IUP GEPI de l'Université de La Rochelle : Approche à l'étude comparative de l'impact de la Détente Instantanée Contrôlée « DIC » sur les propriétés physiques de peau d'orange en poudre obtenue par séchage /broyage.
 - 2005 « Janvier- février » ; ANTUNES Sandra ; Stage de section de technicien Biochimie 2ème année : Approche à l'étude comparative de l'impact de la Détente

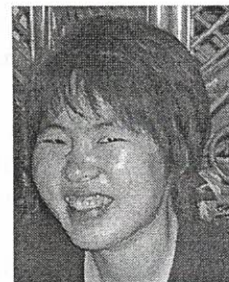
Instantanée Contrôlée « DIC » sur les qualités diverses de poudre de pomme obtenue par séchage /broyage.

- 2004 « Mai- juin » ; ANTUNES Sandra ; Stage de section de technicien Biochimie 1ère année : Etude et analyses comparatives de l'impact de la Détente Instantanée Contrôlée « DIC » sur les propriétés physiques de pomme.
- 2004 « Avril- juin » ; RENARD François ; Stage de licence de l'IUP GEPI de l'Université de La Rochelle : Approche à l'étude comparative de l'impact de la Détente Instantanée Contrôlée « DIC » sur la qualité de poudres de tomate et d'oignon obtenues par séchage /broyage.

DIVERS

Langues: Anglais : bien
 Français : courant
 Arabe : langue maternelle

MAGDALENA KRISTIAWAN



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17000 La Rochelle
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Date of Birth : July 10, 1979

Tel. : +33. 05.46.45.83.42 / +33. 06.66.24.68.53

E-Mail : magdalena.kristiawan@univ-lr.fr

Nationality : Indonesian

Marital Status : Single

EDUCATION

- 2003 - 2006 PhD student in Chemical Engineering, University of La Rochelle, France.
 - Predicted graduation date: October 2006
- 2002 - 2003 DEA in Chemical Engineering, Institut National Polytechnique de Toulouse, France
 - Graduated with rank 9/25 (GPA 12.60 scale 20)
- 1997 - 2002 Engineer of Chemical Engineering, Sepuluh Nopember Institute of Technology, Surabaya, Indonesia
 - Graduated cum laude (GPA 3.60 scale of 4.0), rank 1.

PROFESSIONAL EXPERIENCE

Oct 2003 – present :

- Laboratoire Maîtrise des Technologies-Agroindustrielles (LMTAI), Université de La Rochelle, France

Research activity:

- Thermo-mechanical treatment of Indonesian aromatic plants by Instantaneous Controlled Pressure Drop DIC in essential oil extraction

Supervisor:

- Pr. Vaclav Sobolik and Pr. Karim Allaf

Jan-Juin 2003:

- Laboratoire de Génie Chimique – Institut National Polytechnique de Toulouse, France

Research activity:

- Application of static mixers in miniemulsion polymerisation. Influence of hydrodynamics.

Supervisor:

- Pr. Alain Ricard

Feb 01-Feb 02:

- Laboratory of Chemical Technology, Sepuluh Nopember Institut of Technology, Surabaya, Indonesia.

Research activity:

- Extraction of soybean oil
- Preliminary project of plant design: "Fatty Acid Methyl Ester Sulphonate (FAMES)"

Jul-Aug 2000:

- 2 months work experience with PT. Petrokimia Gresik (Petrochemical Company), Indonesia

1997-1999:

- Private course in mathematics and chemistry for high school students

CONFERENCES

- August 27-31, 2006 – 17th International Congress of Chemical and Process Engineering (CHISA), Prague, Czech Republic. M. Kristiawan, V. Sobolik, K. Allaf. "Extraction of Indonesian Ylang-Ylang Oil by Instantaneous Controlled Pressure Drop (DIC) Process". Oral communication.
- May 21-26, 2006 – Polymer Reaction Engineering VI, Halifax, Nova Scotia, Canada. M. Kristiawan, A. Ricard. "Miniemulsion Polymerization: Influence of the Emulsification Process". Poster.
- November 31 –December 1, 2004 - Les 16^{èmes} Rencontres scientifiques et technologiques des Industries Alimentaires et Forums de Recherche (AGORAL), Nantes, France. M. Kristiawan, V. Sobolik, K. Allaf. "Etude Comparative de l'Huile Essentielle d'Ylang-Ylang". Oral communication.
- June 1-4, 2004 – 5th International Symposium on Mixing in Industrial Processes (ISMIP), Seville, Spain. M. Kristiawan, A. Ricard. Miniemulsion Polymerization in Tubular Loop Reactor Filled with Static Mixers". Poster.

ACADEMIC AWARD

2005 – 2006 French Government Scholarship

LANGUAGES

English, French, Indonesian

INTERESTS AND ACTIVITIES

Food tasting, tennis, travelling, reading, jazz and classical music

