Pilot setup and deployment

Analysis of Rice Production and Market Dynamics in Egypt

30 August 2024

TRACE-RICE with Grant nº 1934, is part of the PRIMA Programme supported under Horizon 2020, the European Union's Framework Programme for Research and Innovation

PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

TECHNICAL REFERENCES

Project Acronym	TRACE-RICE
Project Title	Tracing rice and valorizing side streams along Mediterranean blockchain
Project Coordinator	Carla Moita Brites carla.brites@iniav.pt
Project Duration	September 2020 – August 2024 (48 months)

Deliverable No.	5.2
Dissemination level*	CONFIDENTIAL
Work Package	5
Task	5.2
Lead beneficiary	INIAV
Contributing beneficiaries	University of Alexandria
Due date of deliverable	31 May 2023
Actual submission date	30 August 2024

Written by: Abdelwahab S. Kassem and Carla Brites

HISTORY OF CHANGES			
Date	Beneficiary	Version	Change
02/08/2024	INIAV	V1	Draft version sent to the coordinator
20/08/2024	INIAV	V2	Text revision
23/08/2024	INIAV	V3	Version sent to WP leaders and responsible partners to gather contributions
26/08/2024	IATA	V4	Minor editing
29/08/2024	ITQB/UNL	V5	Minor editing

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EXECUTIVE SUMMARY

This analysis examines Egypt's rice production, highlighting its critical role in the country's food security and economy. As a leading rice producer in the Middle East and Africa, Egypt cultivates approximately 0.65 million hectares annually, yielding around 6 million tons of rough rice.

The primary objective of this report is to assess the strengths, weaknesses, opportunities, and threats (SWOT) facing Egypt's rice industry, and to provide strategic recommendations for enhancing productivity, sustainability, and market growth.

Key Findings:

1. **Production and Productivity:**
    - Rice production is concentrated in the Nile Delta, which supplies 95% of Egypt's water resources.
    - The average yield per feddan (Egyptian unit of area) is 4.5 tons (roughly equivalent to 10.7 tons/ha), influenced by local climatic and soil conditions. Effective water management, aligned with Egypt's Vision 2030, is crucial for maximizing productivity.
    - Significant potential exists in implementing innovative farming models, such as Integrated Aquaculture-Agriculture Systems (IAAS), to boost yields and sustainability.
2. **Technology and Workforce:**
    - Rice cultivation employs various methods, including manual and mechanized transplanting, with a focus on efficient water use through advanced irrigation systems.
    - The industry's success depends on a skilled workforce, though challenges such as labor shortages and the need for continuous training still persist.
3. **External Challenges:**
    - Environmental constraints, including soil salinity and limited water resources, pose significant threats to rice production.
    - The ongoing geopolitical conflict over the Nile water, particularly with Ethiopia's Grand Ethiopian Renaissance Dam (GERD), further exacerbates water scarcity concerns.
    - Government regulations aimed at conserving water have led to restrictions on rice cultivation and exports, impacting farmers' incomes and the industry's long-term sustainability.

SWOT Analysis:

- **Strengths:** Favorable climate, advanced water management practices, high-yield varieties, a skilled workforce, and strong government support.
- **Weaknesses:** High production costs, reliance on traditional farming methods, inefficient water use, soil degradation, quality control issues, fragmented land holdings, and labor shortages.
- **Opportunities:** Adoption of new technologies, government infrastructure development, diversification of rice by-products, and innovative agricultural practices.

- **Threats:** Water scarcity due to the GERD conflict, economic instability, pest and storage challenges, inadequate infrastructure, and the impact of climate change.

Strategic Objectives and Recommendations:

- **Enhance Productivity:** Invest in modern irrigation technologies, research and development of high-yield, pest-resistant varieties, and continuous farmer training to improve productivity and crop quality.
- **Reduce Costs and Address Weaknesses:** Promote mechanization, explore cost-effective farming strategies, and leverage government support to reduce operational costs and enhance efficiency.
- **Improve Post-Harvest Infrastructure:** Develop modern storage and processing facilities to reduce post-harvest losses and ensure rice quality meets international standards.
- **Align with National Policies:** Ensure farming practices alignment with Egypt's Vision 2030, focusing on water conservation and sustainable agricultural development.

1. Introduction

Egypt is a leading rice producer in the Middle East and Africa, cultivating approximately 0.65 million hectares annually, which yields around 6 million tons of rough rice. Rice production is concentrated in the delta of Nile river (Elbasiouny & Elbehiry, 2020; El-Shahway *et al.*, 2016) which supplies 95% of Egypt's water resources (Sušnik *et al.*, 2015). Rice accounts for about 20% of all cereal consumption in the country (Elbasiouny & Elbehiry, 2020; FAO, 2003), underscoring its importance as a staple food. The Egyptian government prioritizes self-sufficiency in rice production, reflecting the crop's cultural and economic significance (Eliw *et al.*, 2022; FAO, 2003).

Key factors affecting the rice production and market include water scarcity, consumer demand and farming practices essential for understanding market dynamics.

Egypt’s rice production primarily meets domestic demand, Japonica varieties, particularly those in the Giza and Sakha series, are highly favored by Egyptian consumers, whereas Indica varieties are less popular due to local preferences for short-grain rice (Badawy *et al.*, 2022; Tabl & Amer, 2018; Mehana *et al.*, 2021).

This SWOT analysis identifies the strengths, weaknesses, opportunities, and threats influencing Egypt's rice industry and offers strategic recommendations for enhancing productivity.

2. Internal Factors Influencing Rice Production in Egypt

2.1. Rice Varieties

Popular Japonica varieties include Giza 177, Giza 178, Giza 179, and Sakha series (Mordor Intelligence, 2024), which are preferred by Egyptian consumers for their short-grain characteristics. Conversely, Indica varieties like Giza 181, Giza 182, and Jasmine, which are long grain, are less favored (Badawy *et al.*, 2022; Tabl & Amer, 2018; Mehana *et al.*, 2021).

Table 1 presents the performance of fourteen rice varieties across various agronomic traits. In terms of plant height, the genotypes ranged from 90 cm for Sakha 101 to 107 cm for Sakha 102, with shorter plants being preferable. For heading date, early maturity is a desirable trait, with Sakha 103 maturing in 88 days, while Sakha 101 took 109 days. The number of tillers per plant varied significantly, from 19.9 in Sakha 103 and 108 to 21.9 in Sakha 101. The genotypes also differed in their growth duration, with Sakha Super 300 maturing early at 114 days, while Giza 182 took longer, reaching 145 days.

In terms of yield components, Sakha 103 had the fewest panicles per plant with 18.5, whereas Sakha 105 had the most with 22. Panicle length ranged from 18.90 cm in Sakha 103 to 24.7 cm in Giza 182. Panicle weight was highest in Giza 181 at 4.40 g. The number of filled grains per panicle varied, with Giga 182 producing the most at 159 grains. Regarding 1000-grain weight, Sakha 106 exhibited the highest value with 28.6 g. Giza 182 achieved the highest grain yield per hectare at 11.40 ton/ha.

For quality traits, brown rice percentages varied from 79.2% in Giza 177 to 80.7% in Giza 181. The percentage of milled rice was highest in Sakha Super 300 at 73%. Broken rice percentages ranged from 6.9% in Sakha 105 to 14.6% in Giza 182. The percentage of chalky and green grains was lowest in Giza 177, with just 1.5%. These results highlight the varieties with the most desirable traits for rice cultivation in Egypt.

Table 1: Vegetative Traits, Yield Components, and Milling Yields of Current Leading Egyptian Rice Varieties

Varieties and vegetative traits					**Yield components**							**Milling Yields**			
Variety	**Plant height (cm)**	**Days of heading (day)**	**No. of tillers/ plant**	**Duration (day)**	**No. of panicles/ plant**	**Panicle length (cm)**	**Panicle weight (g)**	**No. of grains/ panicle**	**1000 grains weight (g)**	**Grain yield/ plant (g)**	**Grain yield ton/ha**	**Brown rice %**	**Milled rice %**	**Broken rice %**	**Chalky and green grains %**
Giza 177*	96	92	20.6	125	20.0	21.60	4.00	146	28.0	35.3	9.7	79.2	69.0	7.9	1.50
Giza 178**	95	91	21.7	130	19.0	19.30	3.97	155	27.0	35.0	10.0	80.3	68.0	8.3	1.70
Giza 179*	99	90	20.6	120	19.5	19.70	3.90	135	27.5	36.0	10.0	79.6	68.0	7.8	1.90
Sakha 101*	90	109	21.9	135	20.4	22.30	4.00	107	28.5	37.0	10.0	80.0	72.0	8.4	1.78
Sakha s.102**	107	91	21.4	135	19.5	20.70	3.88	108	28.0	36.0	9.8	79.4	68.0	7.9	1.93
Sakha 103**	97	88	19.9	120	18.5	18.90	3.87	120	27.9	35.0	9.9	78.6	68.0	8.6	1.60
Sakha 104*	105	99	21.5	140	21.4	20.50	4.00	130	28.5	37.0	10.5	80.3	72.0	7.8	1.75
Sakha 105**	95	95	20.6	125	22.0	19.80	3.90	135	28.4	46.0	9.0	79.6	70.5	6.9	1.65
Sakha 106*	105	92	21.4	120	20.0	18.99	3.96	140	28.6	45.0	9.5	80.1	72.0	7.4	1.72
Sakha 107**	105	90	20.3	115	20.0	19.50	3.89	129	27.0	36.0	9.5	79.3	70.0	8.2	1.90
Sakha 108*	95	105	19.9	130	21.0	20.30	4.00	136	28.0	35.0	10.0	80.3	72.0	8.0	1.85
Giza 181*	103	104	21.4	141	18.6	24.50	4.40	135	27.0	31.2	10.5	80.7	69.7	14.1	2.00
Giza 182*	105	100	21.8	145	20.6	24.70	4.00	159	27.0	32.0	11.4	79.6	70.0	14.6	1.99
Sakha Super 300	105	92	21.4	114	21.6	21.60	4.00	150	28.0	37.0	10.0	80.4	73.0	7.9	1.80

*** Data from trace rice project trials**
****Data from literature** (Badawy *et al.*, 2022; Bagchi *et al.*, 2023; Makkar & Bentur, 2017; Mohammadi & Atungulu, 2020; Ning *et al.*, 2020; Raghu *et al.*, 2020; Shittu *et al.*, 2012; Soliman & Yehia, 2012; Yehia *et al.*, 2016)

2.2. Production and Productivity

Rice is a crucial staple food in Egypt, with an annual cultivation area of 0.65 million hectares yielding approximately 6 million tons of rough rice (Elbasiouny & Elbehiry, 2020; El-Shahway *et al.*, 2016). This production level is expected to support market growth, projected to increase from USD 1.95 billion in 2024 to USD 2.71 billion by 2029 (Mordor Intelligence, 2024).

The primary rice-growing regions include the governorates of Kafr el-Sheikh, Beheira, Dakahlia, Qalyubia, Gharbia, Alexandria, Port Said, Ismailia, and Damietta (Mehana *et al.*, 2021).

The average yield per feddan (Egyptian unit of area) is 4.5 tons (approx imately 10.7 tons/ha) typically ranges between 4 and 5 tons, depending on local climatic and soil conditions (Elbasiouny & Elbehiry, 2020; Salam *et al.*, 2022).

Effective water management, in line with Egypt's Vision 2030, is crucial for maximizing productivity and achieving high yields of disease-resistant varieties (FAO, 2015). Significant potential can be realized through the implementation of a unique rice-fish polyculture model, as part of an Integrated Aquaculture-Agriculture System (IAAS) using Earthen Pond-Based Floating Beds (EPFB) and associated practices (Goda *et al.*, 2024).

The growing adoption of agricultural machinery has substantially increased yield per feddan and reduced post-harvest losses. However, manual planting remains both costly and labor-intensive, driving larger farms to increasingly adopt mechanization.

2.3. Technology Used

Egyptian rice cultivation employs three primary methods: manual transplanting, mechanized transplanting, and seed-drill (Elmoghazy & Elshenawy, 2018). While manual transplanting is common due to its lower cost, mechanized transplanting is gaining popularity on larger farms. Seed-drill cultivation, which conserves irrigation water, is also widely used. Essential irrigation systems, like flooding or basin irrigation, are crucial for rice cultivation, particularly on clay soils where they help retain water, prevent soil erosion, and manage salinity levels (Elbasiouny & Elbehiry, 2020).

2.4. Quality of Rice

Rice quality is influenced by consumer preferences, intended use, and production methods. With a growing focus on self-sufficiency, there is an increasing demand for higher-quality rice in Egypt. Plant breeders are shifting from prioritizing yield and pest resistance to focusing on specific quality traits that enhance economic value. Factors such as optimal harvest time, determined by moisture content and kernel hardness, are critical for meeting national and international standards (Badi, 2013).

2.5. Workforce Skills

The skill level of the workforce is crucial to the success of Egypt’s rice industry. Education and training programs are essential for improving workforce competency. However, the seasonal nature of rice farming presents challenges, with a shortage of experienced labor as workers seek consistent, year-round employment. Expanding training programs can help address this gap, ensuring a skilled workforce capable of supporting the industry's needs.

3. External Factors Influencing Rice Production in Egypt

Rice production in Egypt faces significant challenges due to external factors, primarily environmental constraints. Limited water resources, exacerbated by regional geopolitical issues, and stringent government policies have shaped the current landscape of rice cultivation in the country, leading to a decline in production and a shift toward prioritizing domestic needs over exports. This analysis looks at the external factors influencing rice production in Egypt, with a focus on environmental challenges, the regulatory landscape, and the geopolitical conflict with Ethiopia over water resources.

3.1. Environmental Challenges

Rice production in Egypt faces significant environmental challenges, particularly in the Nile Delta, where high groundwater levels and heavy clay soils complicate effective soil drainage. The northern Delta region suffers from high salinity levels due to seawater intrusion, exacerbated by continuous submergence (Elbasiouny & Elbehiry, 2020). These conditions threaten soil fertility and crop yields, impacting the sustainability of rice production and the USDA Foreign Agricultural Service projects a decline in the area planted with rice in Egypt, with a corresponding decrease in rice production (Elbasiouny & Elbehiry, 2020; Wally & Akingbe, 2020).

Additionally, greenhouse gas emissions, including CO_2, CH_4, and N_2O, contribute to global warming, which further affects agricultural productivity (Elbasiouny & Elbehiry, 2020).

3.2. Geopolitical Conflict: The Nile Water Dispute

A critical external factor affecting rice production is the ongoing geopolitical conflict with Ethiopia over the Grand Ethiopian Renaissance Dam (GERD). As the dam affects Egypt's water supply from the Nile, concerns about reduced water flow and its impact on agriculture, particularly water-intensive crops like rice, have intensified. This conflict underscores the vulnerability of Egypt's agriculture to geopolitical factors and poses a significant threat to rice yields and food security (Elbasiouny & Elbehiry, 2020).

3.3. Regulatory Landscape

The regulatory landscape in Egypt, shaped by water scarcity concerns, has led to government policies that limit rice cultivation areas and impose export bans. For instance, in 2017, Egypt halted rice exports due to government-imposed restrictions aimed at conserving water resources (Eliw *et al.*, 2022). While these policies aim to conserve water resources and ensure domestic supply, they have reduced cultivated areas and affected farmers' incomes. Additionally, rising agricultural commodity prices have prompted further restrictions on exports (Elhini *et al.*, 2024; Eliw *et al.*, 2022), challenging the sector's long-term sustainability and food security efforts.

4. SWOT Analysis of Rice Production and Market in Egypt

4.1. Strengths

- **Favorable Climatic Conditions**: Egypt's climate is ideal for rice farming, supporting high yields.
- **Advanced Water Management**: Strong expertise in water management for cultivation in a water-scarce environment.
- **High-Yield Varieties**: High-yield rice varieties well-adapted, contribute to robust production.
- **Skilled Workforce**: A skilled workforce with extensive experience in rice cultivation supports the industry.
- **Government Support**: Strong governmental support includes infrastructure development along the production chain.

4.2. Weaknesses

- **High Production Costs**: Elevated production costs, especially for small-scale farmers with limit access to modern technology and machinery.
- **Traditional Farming Methods**: Reliance on traditional practices in some regions hinders efficiency.
- **Inefficient Water Use**: Despite advanced practices, water management is not always efficient, leading to waste.
- **Soil Degradation and Salinity**: Soil degradation, particularly due to salinity, poses challenges to sustainability.
- **Quality Control Issues**: Variability in quality and inconsistent control hamper Egypt's ability to meet international standards.
- **Fragmented Land Holdings**: Fragmented land limits economies of scale, making optimization difficult.
- **Labor Shortages:** A shortage of trained labor for modern technologies leads to inefficiencies and post-harvest losses.

4.3. Opportunities

- **Technological Advancements**: Adopting new technologies like terrace farming and laser levelling can enhance productivity and reduce water use.
- **Government Support and Infrastructure Development**: Government initiatives and climate change adaptation funds offer opportunities for modernization.
- **Diversification of By-products**: Diversifying rice by-products, such as rice bran oil, can align with market trends.
- **Innovative Agricultural Practices**: Practices like rice/fish-polyculture in Integrated Aquaculture-Agriculture Systems (IAAS) could revolutionize production.

4.4. Threats

- **Water Scarcity**: The most pressing threat, exacerbated by the GERD conflict, threatens Egypt's share of Nile water.
- **Economic Instability**: Fluctuating economic conditions impact prices and market stability.
- **Pests and Storage Issues**: Pests and poor storage facilities threaten rice quality and yield.
- **Infrastructure Challenges**: Inadequate infrastructure, especially in rural areas, hinders efficient production and distribution.
- **Climate Change**: Increasing climate challenges, such as floods, droughts, and rising sea levels, further threaten water management and rice production.

5. Strategic Recommendations for Enhancing Rice Productivity in Egypt

5.1. Enhancing Rice Productivity

1. **Invest in Modern Irrigation Technologies**:
    - **Optimize Water Use**: Implement advanced irrigation systems to maximize water efficiency in Egypt's water-scarce environment.
    - **Improve Water Management**: Develop infrastructure for efficient distribution and use magnetic techniques to treat saline water.
2. **Promote Research and Development in Rice Breeding**:
    - **Develop High-Yield Varieties**: Invest in breeding programs for high-yield, pest-resistant varieties suited to local conditions.
    - **Focus on Adaptation**: Prioritize the development of varieties resilient to changing environmental conditions.
3. **Provide Continuous Training and Extension Services**:
    - **Enhance Farmer Knowledge**: Offer ongoing training on best practices in rice cultivation, including fertilization, pest control, and efficient water use.
    - **Technical Skill Development**: Equip farmers with skills to adopt modern technologies, improving productivity and crop quality.
4. **Encourage Farmers through Subsidies and Access to Credit**:
    - **Encourage Cultivation**: Provide subsidies and affordable credit to motivate farmers to increase production and adopt advanced technologies.
    - **Support Small-Scale Farmers**: Establish cooperatives to pool resources, reduce costs, and provide access to necessary equipment.
5. **Improve Post-Harvest Infrastructure**:
    - **Enhance Storage and Processing**: Invest in modern post-harvest facilities to maintain rice quality and reduce losses.
    - **Meet International Standards**: Optimize the supply chain to ensure that rice products meet international standards.

5.2. Reducing Costs and Addressing Weaknesses

1. **Develop Cost-Effective Farming Strategies**:
   - **Lower Operational Costs**: Explore strategies to reduce farming costs, such as bulk purchasing of inputs and shared machinery.
   - **Increase Mechanization**: Promote mechanization to lower labor costs and increase efficiency.
2. **Leverage Governmental Support**:
   - **Access Funding**: Utilize government programs and international funds to improve infrastructure and adopt climate-resilient practices.
   - **Align with National Policies**: Ensure farming practices are consistent with national water conservation and agricultural development goals.
3. **Expand the Use of Technology**:
   - **Implement Precision Agriculture**: Utilize data and technology for precise application of water, fertilizers, and pesticides.
   - **Invest in Biotechnology**: Support the development and adoption of biotechnology to enhance productivity.

6. Conclusion

The Egyptian rice industry stands at a crossroads, facing both significant opportunities and challenges. By addressing key internal and external factors, Egypt can strengthen its rice sector, ensuring food security and economic stability in the face of environmental and geopolitical pressures. Strategic investment in technology, infrastructure, workforce development and leveraging government support will be crucial to maintaining Egypt's position as a leading rice producer in the Mediterranean region.

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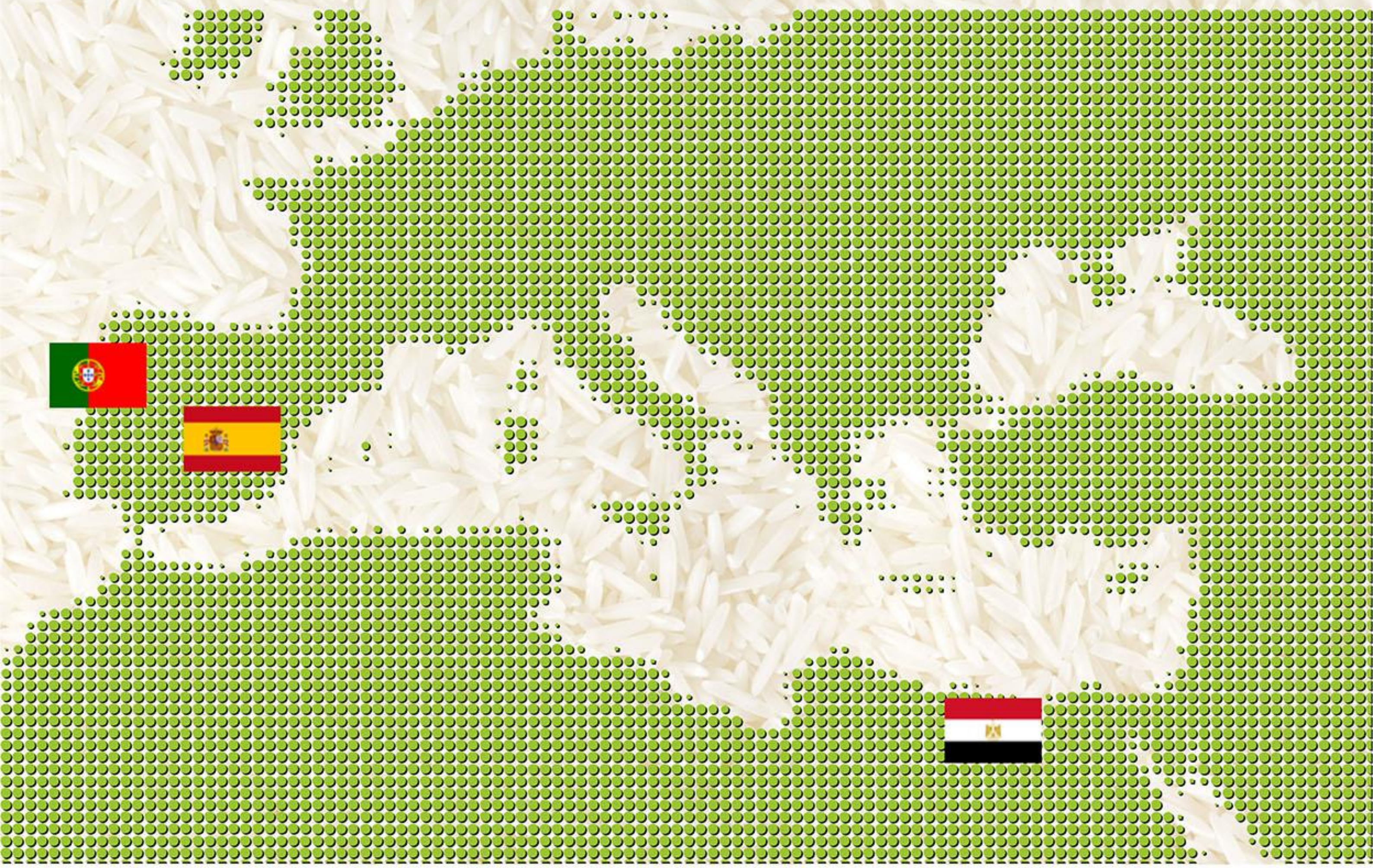
Trace Rice



TRACE-RICE Consortium

Instituto Nacional de Investigação Agrária e Veterinária, I.P. (iniav)

iBET Instituto de Biologia Experimental e Tecnológica

ITQB Universidade NOVA de Lisboa

Casa do Arroz

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