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Handbook for the Production of Extruded Fortified Rice Kernels

WFP
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Global Alliance for Improved Nutrition

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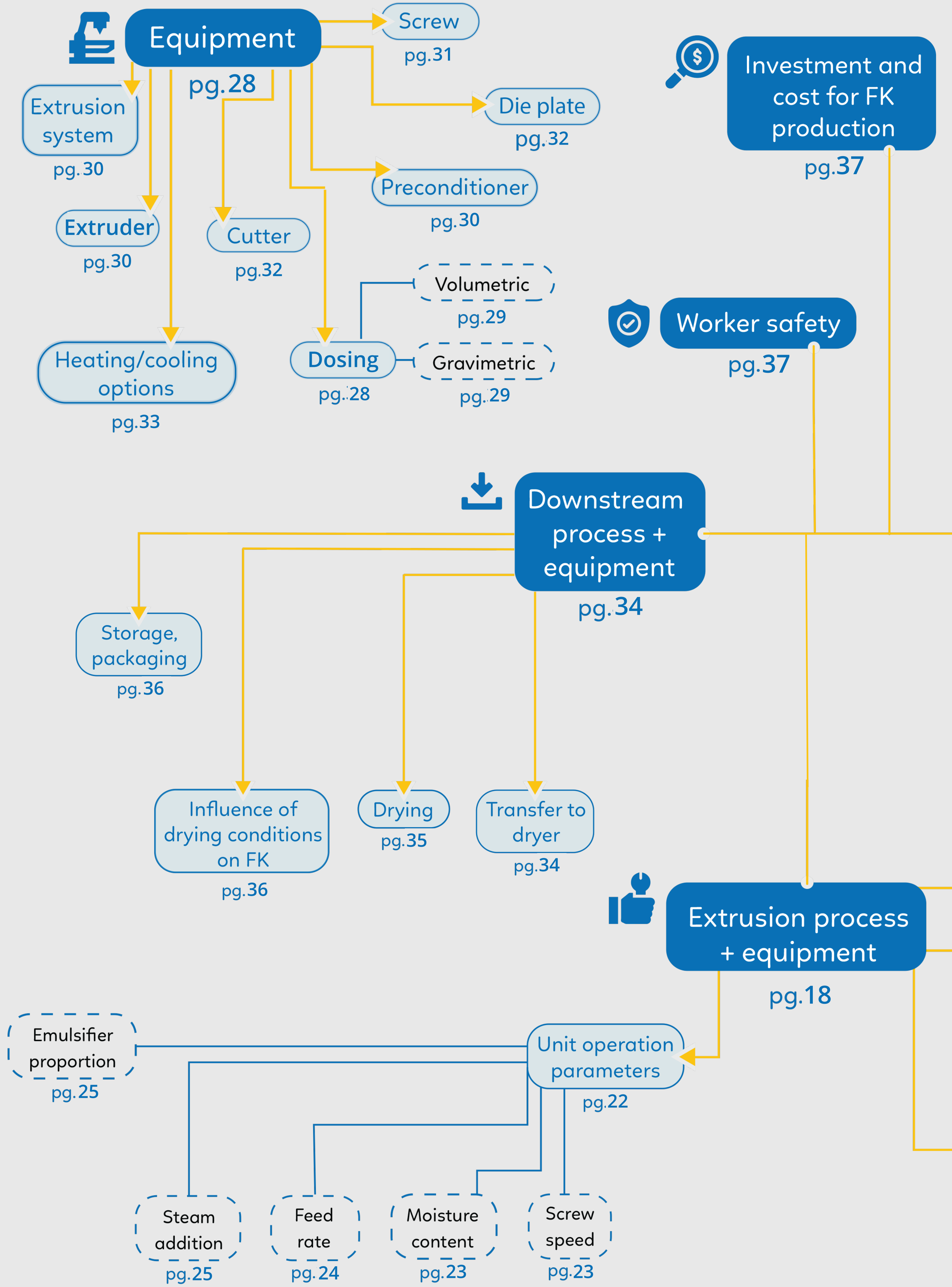

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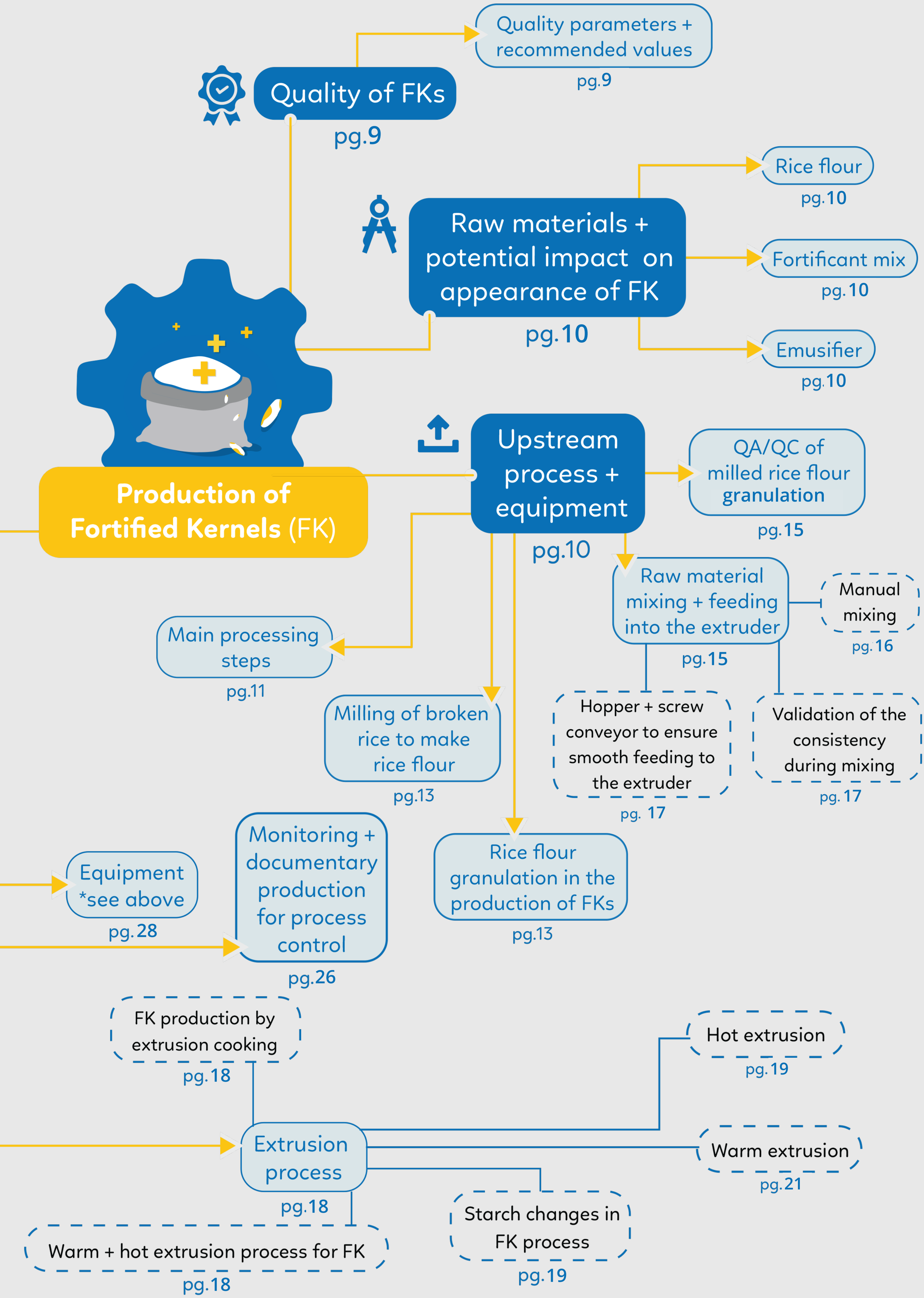

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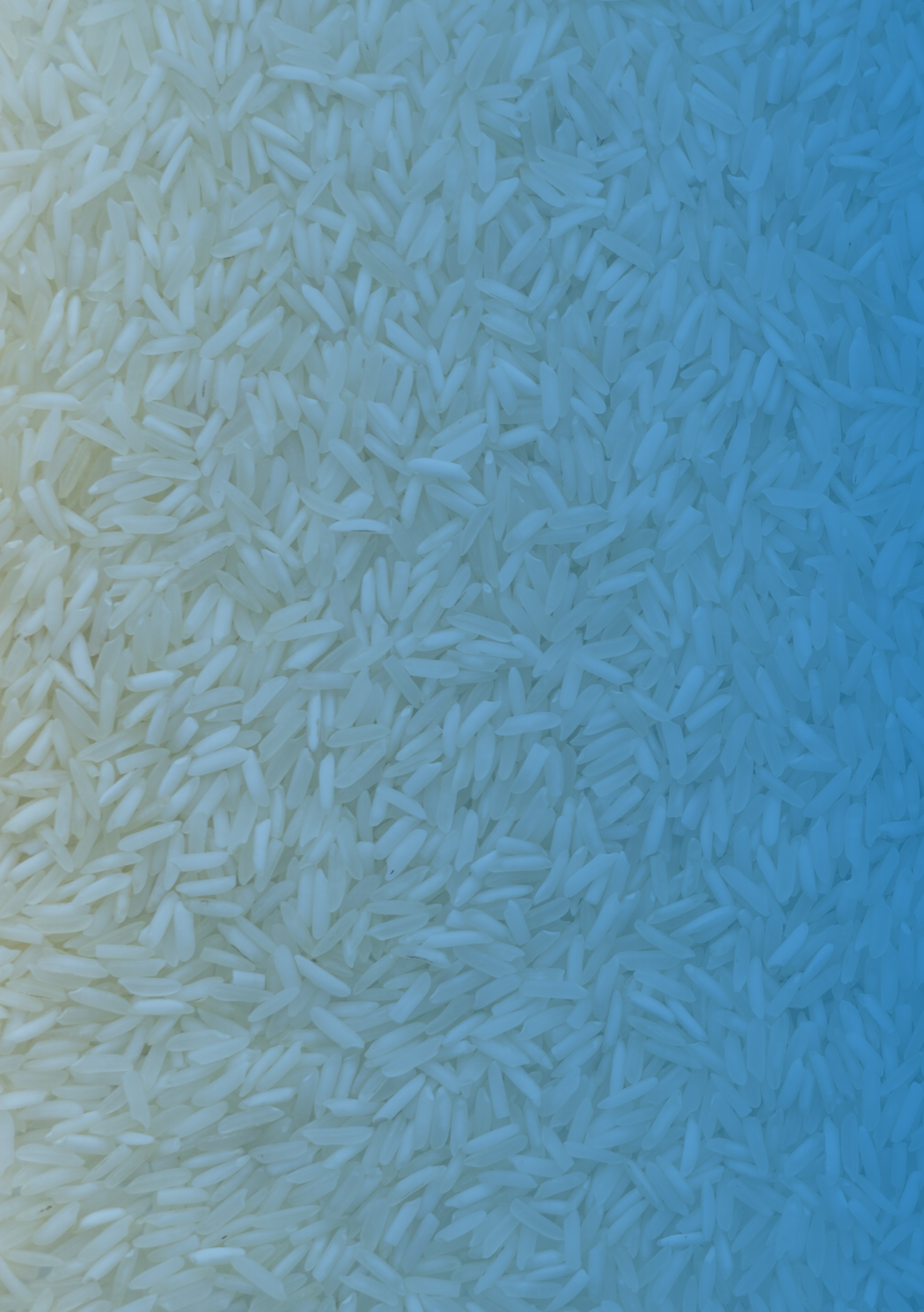

Acknowledgements

This Handbook was developed as a response to the growing interest in rice fortification using extrusion technology. Manufacturers of fortified kernels and programme personnel expressed a need to have a readily available handbook that could answer key questions related to the effects of extrusion technology on this product's fundamental quality attributes. This Handbook would not have been possible without Thomas Brümmer (Consultant), the main author; Carla Mejia (World Food Programme (WFP), Regional Bureau-Bangkok), the technical lead; and Dora Panagides (WFP, Nutrition Division) the overall project coordinator.

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1. Preface

More than two billion people are deficient in essential vitamins and minerals. Such micronutrient deficiencies are usually the result of poor quality diets, and lead to a range of disabilities including impaired brain development and cognition, impaired immunity against disease, poor pregnancy outcome, poor growth, impaired work capacity, blindness, and even death. These poor health outcomes restrict the intellectual potential of the individual, reduce the earning power of the family, and decrease the gross domestic product of the country [1,2].

One way to improve food quality in the diets of vulnerable populations is by adding vitamins and minerals to commonly consumed foods, otherwise known as food fortification. This has long-lasting positive effects on people's lives by reducing micronutrient deficiencies. Renowned scientists and Nobel laureate economists endorse food fortification as a safe, sustainable, cost-effective intervention for public health and economic development [3,4].

Rice is a staple food for over half the world's population, many of whom live in poverty. While it is a good source of energy, many nutrients are lost in the milling process which make it a poor source of essential vitamins and minerals [5]. According to the World Health Organization (WHO) Guidelines on rice fortification, "Due to its wide local consumption, acceptability, reach and quantum consumption, rice far exceeds the requirements of a staple food vehicle that can be considered for fortification purposes at a population-level intervention" [6]. With rice fortification technologies now well-established, and published studies providing evidence of the impact of rice fortification, multiple stakeholders are well-positioned to make fortified rice available through social protection programmes, as well as in the market.

This handbook was developed in response to an increasing need for guidance on the production of fortified kernels (FKs) made from rice flour, vitamins, minerals, and water using extrusion. It is meant for producers of FKs and for food science professionals supporting rice fortification programmes, as well as other interested stakeholders including regulatory monitoring technical agencies and research organisations interested in providing technical assistance in extrusion for fortification.

The overall objective of this handbook is to provide basic technical guidance on the production of FKs, using extrusion technology. It aims to address the key challenges faced in the production process and to support decision-making and troubleshooting.

It gives general details of the production process and technical requirements with the aim of decision making. It provides information on raw materials, the extrusion process, equipment, and general quality attributes of FK. This differs from previous manuals as they have focused primarily on final fortified rice. This manual is meant to guide the selection of an extrusion line for production of FKs. It is a "quick" reference and not a comprehensive manual on production. Given particularities associated with equipment manufacturers and brands, it is expected that food manufacturers will receive more specific technical support from the company from which the extrusion equipment was purchased.

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1 Horton, S., Alderman, H. and J.A Rivera. Copenhagen Consensus 2008 Challenge Paper - Hunger and Malnutrition. March 6, 2008. Copenhagen Consensus Center

2 Horton, S., 2006. The economics of food fortification. J Nutr 136 (4), 1068_1071

3 Black RE, Allen LH, Bhutta ZA et al. Maternal and Child Undernutrition Study Group. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 2008;371:243–260

4 Bhutta ZA, Das JK, Rivzi A et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet 2013;382:452–77

5 Champagne ET, Wood DF, Juliano BO et al. The rice grain and its gross composition. In: Champagne ET, ed. Rice: Chemistry and technology. 3rd ed St Paul, MN, USA: American Association of Cereal Chemists, 2004; pp. 77-107

6 Guideline: fortification of rice with vitamins and minerals as a public health strategy. ISBN 978-92-4-155029-1. WHO, 2018

2. Introduction

Fortification of commonly consumed staple foods is an important strategy for reducing the burden of vitamin and mineral deficiencies in a population. Multiple studies have established that, with the appropriate levels and forms of micronutrients, and with appropriate technology, fortified rice is an effective intervention to improve micronutrient status [7]. It has the potential to benefit almost half of the world's population as the majority of the more than three billion people who consume rice as their main staple are unlikely to have an adequate micronutrient intake.

Rice can be fortified with a wide variety of vitamins and minerals, including iron, zinc, and vitamins A, B_1 (thiamine), B_3 (niacin), B_6, B_9 (folic acid) and B_{12} [8,9]. Rice fortification that retains micronutrients after preparation and cooking includes a two-step process. This involves the manufacturing of FKs containing appropriate vitamins and minerals, then blending those FKs with milled rice to create fortified rice. The type of fortificants chosen, and the technology used, ensure that fortificants remain stable and bioavailable under different conditions of storage, transportation, preparation and cooking. Extrusion can produce FKs that can be blended with milled rice to produce fortified rice that is effective and acceptable to consumers in colour, taste and texture [10].

The acceptability and effectiveness of fortified rice depends on the quality of the fortification technology, the type and levels of nutrients added, and consumer preferences. Therefore, production of quality FKs is a vital aspect of rice fortification programming to ensure a positive impact on the micronutrient status of the people consuming the fortified rice.

3. Production of fortified kernels

To produce fortified kernels using extrusion, dough is made from unfortified rice flour, a mix of vitamins and minerals, water and steam. The dough is then processed through an extruder, shaped into a grain-like product that resembles rice kernels and then dried. These FKs are then mixed with milled rice at various ratios. Hot extrusion is when the extruder is set to fairly high temperatures (slightly above 100°C); warm extrusion uses temperatures between 70°C and 100°C. Cold extrusion is similar except it utilizes a simple forming extruder or pasta press which does not involve any additional thermal energy. Fortified kernels can also be produced using a rinse-resistant coating, but this document will only focus on hot and warm extrusion as they are the most widely used technologies for FK production. Moreover, no small and medium enterprises were found to be applying rinse resistant coating technology at scale.

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