

Gamifying the Rice Industry: The 'Riceville' paradigm.

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Abstract. The global agriculture industry remains underdeveloped due to a lack of education among farmers about best practices and technologies. Similarly, corporate gamification and the rise of serious games have demonstrated their effectiveness in education within our era. The implementation of gamification principles through accessible technological platforms has massive potential in building best practices in the agriculture industry. Rice agriculture has a resistance to the adoption of new methodologies and technologies. This paper introduces 'Riceville', a game used to simulate a virtual farming environment promoting the use of effective best-practices introduced by leading rice organisations like the International Rice Research Institute (IRRI). By gamifying best practices, the social norms of low adoption and perception of risk can be altered to boost the reception of novel practices within the industry. This will not only serve to modernize the rice industry but also improve yields for farmers while helping agriculture companies increase exposure.

Keywords:

Gaming · Gamification · Rice · Agriculture · Technology · Management · Production · Management · Serious Games · Agriculture

1 Introduction

Many farmers around the world are still using outdated traditional agricultural practices. Despite, a large amount of resources from global charities, governmental and commercial agricultural organisations allocated to educating the farmers, the resistance occurs when trying to convince them of the effectiveness of novel technologies. The scarcity mindset within farmers in one of the driving factors contributing to low rates of adoptions, ultimately stunting the growth of industries, especially ones typically characterised with low levels of education. Mainstream platform technologies such as smartphones are now able to successfully penetrate rural farming communities such as the case of high smartphone adoption of farmers in Myanmar.

This platform presents an exciting opportunity to catalyse the education of farmers. One such means is through gamification that rewards best farming practices, most effective technologies and even proven agronomy. This paper suggests a farming game that targets rural rice farmers, enabling them to simulate farming and get rewarded for using the most route to grow their farm. In addition, to raise competition and stickiness,

the incorporation of a ranking system can be a further form to gamify the platform. It may accelerate the adoption of best practices and technologies whilst providing a great platform to change the entire mindset of whole rural village communities that are predominantly farming focused.

2 The gamification era.

Gamification as an academic field and also as management and operations practice is still in its infancy, treated as an original idea. A definition that is frequently cited in relative works presents gamification as the incorporation of game elements into non-game contexts [1]. The word gamification could refer to games created with the purpose of turning a tiresome and hard task into an engaging activity, while the incorporation of educational features is desirable. Furthermore, gamification may refer to the evolvement of an existing structure, like a website, an enterprise application or an online community, to an educational tool by applying some of the techniques and ideas that make games appealing. In other words, gamification is the strategy which uses game mechanics and techniques in order to drive user behaviour by increasing self-contribution.

Gamification is a popular topic among business professionals besides the academia and is exercised in sectors such as engineering, medicine and military. It is described as serious games, pointification, behavioural games and games with a purpose, with the aforementioned terms being similar, yet different. The work of Seaborn and Fels [2] is proposed where several definitions of gamification and the related concepts are categorized and elucidated. Gamification is considered by industries as a tool for supplementing branding initiatives or a business strategy tool [3], [4].

3 Corporate Gamification and serious games.

The term "serious game" has been used since the decade of 1960, long before the introduction of computer and electronic devices into entertainment [5]. It was used to define gamified processes without the use of technology as a scenarios-based model operating metaphorically as a game of strategy with probabilities, possibilities and skills on handling information, conditions, decisions and results.

Many references define serious games or applied games as games designed for a primary purpose other than pure entertainment. The "serious" adjective is generally prepended to refer to products used by industries like defence, education, scientific exploration, health care, emergency management, city planning, engineering, and politics [6]. This, kind of biased, characterizations can be unfair to the entertainment games that do have serious scenarios, technology, graphics, sound, animation, effects and other elements that can turn entertainment games into unique experiences. Serious games are successful only if they are designed based on entertainment games design principles. A good serious game must be entertaining or at least so immersive that players are addicted to play. What is serious game, and what is not serious cannot and shall not be determined by the type of its user's target group, functionality or operations,

but solely on its quality, effectiveness and benefits to those using it for a specific purpose, any purpose.

4 Examples of industry serious games.

Gamification is often correlated to digital game-based learning (DGBL), which is defined as the use of “game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning and solve problems” [7]. In more specialized topics in engineering, gamification includes game systems in CAD-type environments. Broughtet al.[8] developed Virtual Training Studio where users train to perform assembly tasks. Li, Grossman and Fitzmaurice [9] presented GamiCAD, a gamified tutorial for AutoCAD, based on missions, scores and rewards. Additionally, a gamification approach was designed by the RWTH Aachen University and tested in cooperation with a German car manufacturer, in order to enhance training strategy for workers in low volume assembly systems and increase ramp-up performance, with promising results [10]. Furthermore, Hauge and Riedel [11] tested two serious games, namely COSIGA and Beware, in order to evaluate gamification for teaching engineering and manufacturing.

Applying game technologies in engineering is a quite unique business area, and even quite unique research area). An efficient use of existing digital content such as 3D technical CAD drawings together with game technologies is one of the key elements of gamified industrial applications. IndustrySim (Fig. 1) is an example with CAD drawings of coal fired power plant. IndustrySim has characteristics which can be found from IS research framework presented by Hevner et al. [12].

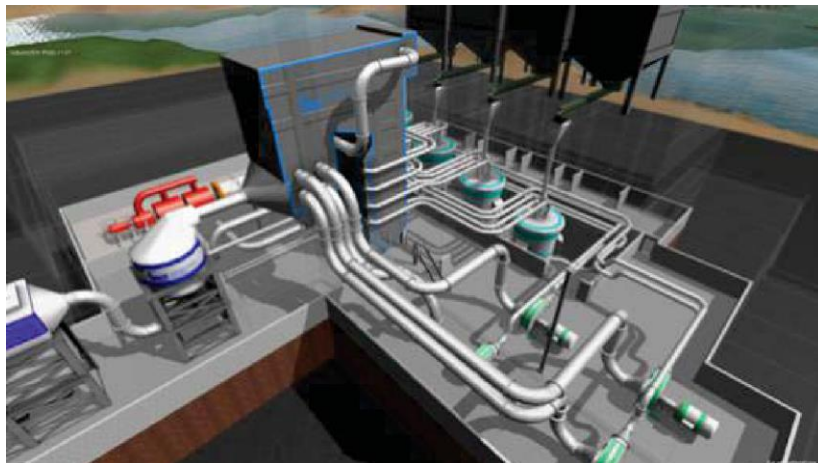


Fig. 1. Screenshot (with the GUI disabled) of an example coal-fired power plant built inside the IndustrySim prototype.

One of the most successful games in production management is Plantville. The online game was released in 2011 by Siemens and revolutionized production gamification. Taking part of its name after the popular online game Farmville, Plantville enables

players to immerse themselves in an production environment, make decisions to change and improve it, and interact with other colleagues.

The game simulates a plant manager's experience and challenges players to increase productivity and sustainability of an industrial plant. During the game, players are faced with the challenge of maintaining the operation of their virtual plant while trying to improve key areas of manufacturing (fig. 2). The players are measured against on several Key Performance Indicators (KPIs), that go beyond the production management process as they approach the plant's operations in a wholistic way covering safety, on time delivery, quality, energy management and employee satisfaction targets [13].

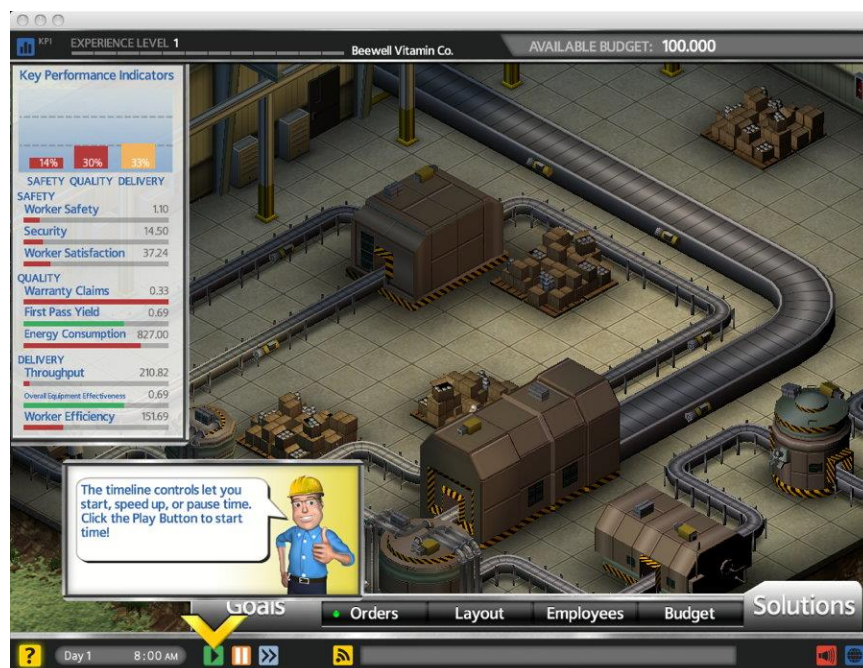


Fig. 2. Screenshot from the Plantville game [14].

Plantville players have the option to select one of the three different plants the game provides, in three different sectors (vitamin plant, bottle production plant and train building plant). Plant engineering experts from Siemens worked closely with gaming experts from Pipeworks Software Inc., developer of software and technology for Xbox 360, Nintendo Wii, Playstation 3 and other gaming consoles. This collaboration delivered a visually rich environment which made the game a big success.

A similar example in popularity and success of an industry serious games is Quest for Oil, a real time strategy resource management game in the area of oil exploration has been developed by MAERSK in 2013. The game is composed from three mini games related to production management, drilling management and seismic management (figure 3.). The players can experience off-shore drilling being on an oil drilling rig in the pursuit of oil in the North Sea and off Qatar. The players go on a

subsurface journey, exploring the geographical underground of the oil industry at both locations. The goal of the games is to test the players analytic skills on searching for oil based on a seismic map while they face challenges surrounding the oil exploration [15].

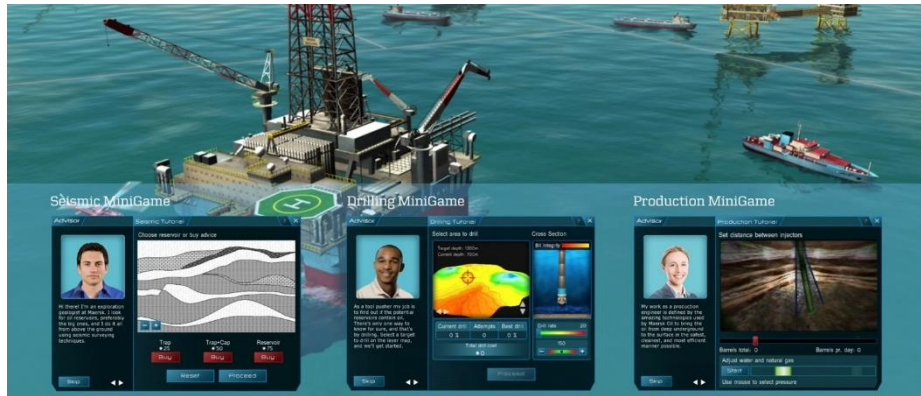


Fig. 2. Screenshot from the Quest of Oil game [16].

IndustrySim, Plantville and Quest for Oil are indicative examples of serious games that made an impact in the adaptation of games in production and operations management, challenging more industries to follow this path.

5 Serious games in agriculture management.

Agriculture management in our modern day requires much planning, allocating proper resources, dealing with unorthodox weather patterns and financial constraints. It also requires managing a good deal of risk as profits are more often than not tied to a good crop. Furthermore, globally agriculture is being disrupted by new smart farming machinery, precision agriculture and digitization. Managing an already complex process while integrating new potential challenges can make agriculture management difficult especially for small holder farmers who still produce majority of the world's food supply.

Serious games offer a way to make the managing this complex process easier. Balancing resources, integration of new events and planning environments are a common part of many famous game plays. For example, sim city which teaches basic urban planning would be a concept easily transplantable onto a farm environment. It would offer a way to quickly learn and pick up basic farm agronomics. Furthermore, it offers a quick way to learn and pick up the dynamic nature of the changes affecting agriculture that perhaps older farmers had never seen before due to climate change and urbanisation. Agricultural games designed with education in mind have long been available. An example of this is AgVenture, a computer game designed to educate farmers and students on basic farming strategy [17].

In recent years, there have also been agricultural streams that have a greater reach inciting interest from a more mainstream player base. The farming simulator series of

games is a prime example of this. Released in 2012, the video game has sold over four million copies combined just two years after it's release. The players in this multiplayer game are involved with planting crops, mowing wheat, hiring manual labour, and other activities [18].



Fig. 3. Screenshot from the Farming Simulator 14 multiplayer game.

There is a clear demand for such a game from younger generations evident from the main player demographic for this series being young children and farmers. Furthermore, the agricultural niche is becoming ever more mainstream demonstrated through electronic sport (e-sport) competitions that are starting to appear including the Farming Simulator Championship with a total of 250.000€ in prizes (a 150.000€ increase since the competition's first year, one year ago) [19]. This opportunity has not gone unnoticed as several research institutions have already begun to recognise its potential and begun developing serious games targeted at the agriculture sector [20], [21]. In fact, in a study done on serious games as a tool for sustainable development, agriculture was recognised as a sector for focus [22].

6 Challenges in the rice industry.

Rice is one of the 3 main crops in the world but the most important one for majority of middle- and low-income countries. Over 500 million tons of rice are produced and consumed each year. It's importance cannot be understated not just because it's a staple of over half the world but because any disruption to the industry would cause massive repercussions for food security and global income. For example, in 2008 when the price of rice tripled, the world bank estimates 100 million people went below the poverty line as a result [23].

Over 70% of the world's rice is produced by smallholder farmers living in low to middle income countries. Their farm sizes are typically no larger than 2 acres. These farmers face a variety of issues due a lack of education, climate change and rapid urbanisation. They normally use traditional and improper agricultural practices that result in low yields and low income as a result. Penetration of new technologies including machinery and best practices such as proper usage of pesticides are slow because they are rarely understood by the farmers [24]. However, when a new practice

or technology is adopted, it has the potential to spread quickly but farmers typically implement it without proper understanding which is risky as it might result in ruined crops. With low incomes, a lack of understanding of best practices, this puts the world's food security of rice at risk.

However, penetration of smart devices is surprisingly high in most smallholder populations. Despite gaps in their understanding of these devices, items like smartphones have become a daily tool that farmers use for a variety of tasks. Hence this offers a touchpoint for serious games to be able to deliver educational content to rice farmers in particular. A serious game has the potential to provide a method to teach farmers best practices in the industry as well as allow them to practice managing scenarios that they otherwise would not risk in real life. This could potentially allow them to make better decisions and implement best practices for their actual crops. Finally, such a game would also serve as a platform for agricultural companies who have historically found it hard to market to rural smallholder farmers to engage with them.

7 Potential of Rice Industry in Asia

The rice industry in Asia, in particular the rice farmers of Asia which number a population of more than 200 million [25], would be particularly suited for a serious game. Most of the world's rice production takes place in the Asia Pacific region (fig. 4) [26] which is also the region with the most games as more than 900 million were recorder in 2016 (Fig. 5) [27].

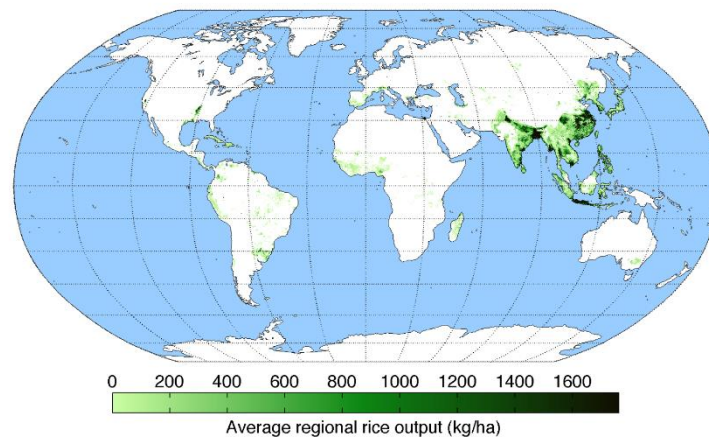


Fig. 4. Screenshot from the Farming Simulator 14 multiplayer game.

Furthermore, serious games set in the agriculture content have been shown to attract farmers not just regular players. Farming simulator, a serious game for agriculture which has over a million users that is targeted to western countries like the United States and the United Kingdom, reported that over a quarter of their users have a background in farming with up to 10% full time professional farmers. Interviews with these farmers demonstrate that professional farmers use these serious games to learn more about

machinery that they don't have access to in real life. To test out various scenarios on their crops and simulate their real-life processes or even just for the satisfaction of being able to try something new without real life risk [28]. It demonstrates that professional farmers are already utilizing serious games to increase their own sense of knowledge and fulfill creative desires that would be too risky to implement in real life.

This provides an exciting opportunity for serious games in the rice industry because majority of rice farmers are located in the Asian Pacific Region, while majority of gamers also reside in the same location demonstrating a large overlap of potential demand. Furthermore, a serious game in agriculture from another region has shown to be able to attract significant interest from the farming population and been successfully leveraged for its benefits. The same could happen in Asia as well for the small holder rice farmers.

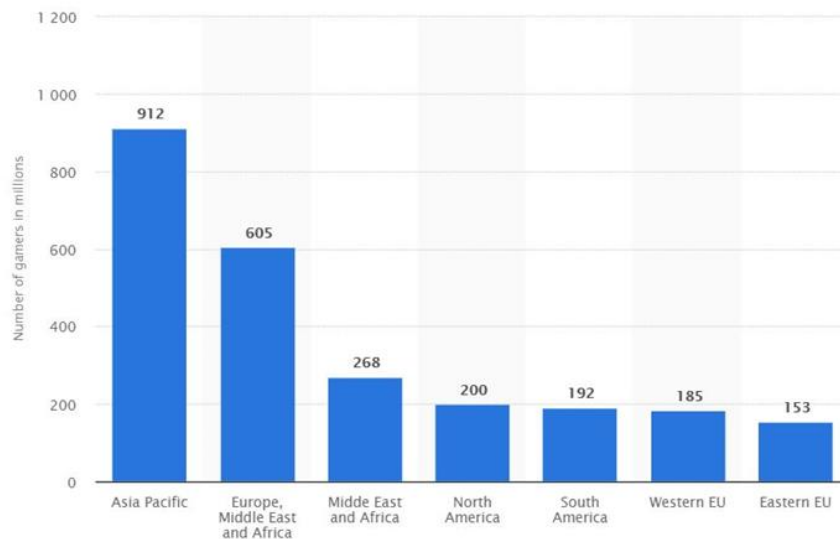


Fig. 5. Number of video gamers worldwide in 2016, by region (in millions)

8 The Riceville case.

A key issue mentioned above regarding the rice industry is the need to accelerate adoption of new agriculture technologies and practices in the farmer demographics. Additionally, there is an exceptional rate of smartphone adoption within the same populations of low economically developed countries including Myanmar. This presents an exciting opportunity to leverage new technology adoptions to simulate a variety of basic agricultural farming tasks to promote farmer education. This can be done by gamifying and rewarding behaviours which reflect real life best farming practices. Examples of which best farming practices can be modelled after could include IRRI's Best Management Practices for differing land and weather conditions. In addition to Best Management Practices, the game could also be a platform to simulate and educate basic agronomics as well [29].

It would be a basic simulation game that simulates relevant factors that are involved in farming conditions. Factors including cost of farming inputs, growth rates, weather conditions, soil conditions, fertilizer effectiveness and etc. can all be simulated. Ultimately with proper simulation of real-life farming scenarios for the farmers, this may be a form of education, through gamification, can accelerate their learning.

9 Riceville operations.

The foundations of the game are simple and follow a traditional city-builder/resource management strategy game such as Cities Skyline or the Farming Simulator series of games respectively to begin with [30]. The player takes the role of a farmer who has the objective of making more profit for his farm. A variety of mechanisms are available for this to occur that would reflect real life opportunities so that the farmer playing the game would be able to learn and implement learnings to real life.

The game begins with access to a basic plot of land. Additionally, with some starting resources, that are initially limited, which may include: money, experience, influence, reputation and other. They can use these starting resources to purchase seeds, fertilizer amongst other farming inputs. All these can be used to progress through a three-part cycle: Planting and sowing, crop maintenance and crop selling. Each part designed with the intention to allude to and promote the use of agricultural techniques and technologies reflective of real-life best practices. The planting and sowing cycle would include processes such as choosing the best types of seeds for the best soil types, choosing which day to plant the seeds to avoid bad weather conditions or which machines to use to decrease the amount of time required for planting. Crop maintenance would involve selecting the best pest control substances and techniques to use within the game. Finally, the crop selling stage would involve the process of selling different varieties of crops during the best time to maximize return on investment of initial resources.

During the different stages, different resources could be rewarded for various actions done within game. An obvious example would be a reward of money during the crop selling stage. Another example is experience that can be gained in the planting and crop maintenance stage. This will be a pivotal part in the progression of the game for the player through the upgrade mechanism for different assets in the farm. The resources gained can be used to purchase/add value to existing farming inputs or enhance existing processes/assets used by the player. Enhancements and the usage of different assets/technologies within the game will all have an influence on the final crop that is to be sold and increase efficiencies of other processes. This creates a platform in which farmers have a safe environment to test out/simulate new technologies on a virtual farm. By seeing the positive effects, it may also encourage them to upgrade their real-life existing processes/technologies.

To facilitate the engagement, the gamification element of a ranking system is incorporated to boost competitiveness between players. A ranking system based on score given to combined achievements or experiences the player has. This also creates a platform to highlight model farmers/farms. An interface has been designed where players can visit other players' farms to see ideal farm practices that will be positively

reinforced. Furthermore, the implementation of daily rewards from consecutive playing of the app would also be appropriate to increase the stickiness of the game.

To once again boost farmer engagement, the ranking system selects players who could be awarded rewards in real life for example via partnerships with companies/governments/NGOs to further emphasise that despite the simulation being a game, there are real life benefits through both implementing the structure and also possible materialistic rewards. An example is a partnership with an agricultural company where top ranking farmers can get subsidized rates for that company's fertilizer. Non-agriculture related organisations may also be appropriate such as a partnership with telecom companies for telecommunication benefits.

One of the most important partnerships would be with a knowledge partner such as a rice research organisation which constantly updates and refines a 'best practices' set of guidelines to instruct farmers. Obtaining this input can turn the game into an engaging, yet highly educational resource for farmers to have fun whilst they learn the best agricultural practices in the world. Even with the possibility of gaining real life benefits.

10 Riceville contribution to the rice industry.

Benefits to the farmer are obvious, education on modern agriculture practices will greatly increase the productivity of the farmers. This will also raise the overall productivity of the rice industry in tandem since the farmers are at the beginning of the supply chain, directly increasing the volume of production. This also provides an exciting opportunity to influence the decision of which rice variety types a farmer should plant that is desired by a nation's rice industry.

Disaster scenarios such as a drought is predicted can be prepped against by setting those weather conditions for the players and farmers to play through. Successful players who heed in game warnings will be rewarded by having more produce to sell at the end of a game cycle. On an individual farmer level, this educates them on what to do to prepare for certain conditions whereas on an industry level, overall rice output could be maximized given whatever weather conditions take place.

Finally, Riceville could act as a bridge between existing rice institutions/ businesses and farmers. It provides a win-win solution for many stakeholders in relation to farmers. For the policy makers, they can simulate new policies in game to gain data on how new policies could affect the farmers whilst farmers can get up to date information and prepare how to address new policies appropriately to maximize their gains. Even for corporations, that provide products/ services for farmers, Riceville is another route to engage with the farmers directly whether through paid sponsorship or to increase familiarity of their business concepts.

11 Areas of further research.

Further research on the gamification of the articular sector will be extended to the design of Riceville under Virtual and Augmented Reality (VAR) technology in order to achieve more immersion and provide more effective results and benefits to the

players who could be the actual or the potential rice farmers. VAR can enable virtual manipulation and provide exposure to new technologies - by being able to visualise and handle virtually, it can boost learning of how new machinery can work. VAR can also help train farmers to recognise negative signs regarding their crops: e.g. to spot certain plant diseases. A VAR version of Riceville could offer exciting opportunities for farmers such as enabling the virtual manipulation to tools or technology that they haven't bought yet or it not available in their region. Alternatively, it could also provide them training for new machinery that they do not fully know how to use without the risk of damaging their crops.

Other areas to move into would be using serious games to not just teach farmers best practices of rice but for other crops as well. They would be able to experiment with different harvest seasons and simulate in advance what would be the best type of agriculture expansion for investment. For example, a rice farmer would be able to decide if he should invest in purchasing a cow or perhaps try planting maize as well as rice for the next harvest. It doesn't have to just stop at farming either, educational content of relevance to small holder farmers could be taught as well for example, home economics or simulations of other business industries.

12 Conclusions.

The adaptation of serious games is a growing challenge and opportunity for all sectors to primarily achieve employee engagement and operations efficiently. However, there are sectors like the agriculture that present a decline of the people involved in it, and especially the farmers, require any possible help from technology in order to restructure its workforce in size, skills and commitment. Riceville is not only a serious game attempted to gamify the agricultural industry but a shared value social innovation technology aiming to improve the lives of hundreds of thousands rice farmers and revitalize international the rice farming community. The proposed technology emphasizes more on the social contribution to the rice farmers and the rice industry, than the operations efficiency and profitably by the optimization of the farming process. Riceville is a game that can prove that gamification can be aligned with the UN sustainable goals, improve the lives of the people, reduce hunger and poverty, and assure decent work and economic growth.

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