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Developing green education: The path for Wageningen University to become smart university in the Netherlands

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Abstract
Wageningen is a research-oriented university in the Netherlands. Following nearly ten years of transition (2014-2023), Wageningen has established a strategy and steadily built a smart green education ecosystem in which modern technology and sustainable development principles are the focal points of all endeavors, including scientific research, startup innovation, university administration, training, and international collaboration. Wageningen's green education ecosystem has evolved into a model for the smart green university movement with the appropriate development strategy that is in line with current trends. Thanks to this gateway, Wageningen is now the smartest university in the Netherlands and is listed in numerous prominent global university rankings.

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1. Introduction

Wageningen University & Research (also called Wageningen UR; abbr. WUR) is a public university at Wageningen, the Netherlands. The university's development history spans over 100 years; at the beginning National College of Agriculture was established in 1876 (Arthur Mo, 2016). The transition is made from National College of Agriculture to WUR with some noteworthy landmarks: 1) in the 1960s, it focused on teaching the programmes of agriculture; 2) in the 1970s, it expanded more and more to the area of applied research; 3) in the 2000s, it incorporated research center and became WUR. In 2016, WUR firstly achieved high rankings in 2 international rankings: QS World University and Shanghai Ranking (ranked 119th and 150th). In 2022, WUR was ranked high in at least 10 World University Rankings.

WUR has been excellent international university in the fields of life sciences and agricultural research (USNWR, 2023). Which path motivates WUR to become smart university in the Netherlands is the interest of quite a few universities and research institutes in the world; such learning experience is also very useful for university institutions to court, find out and study. Which trends can WUR's course of action to become green university open up for world university education? The paper presents WUR's process of developing green educational ecosystem and its achievements. This is the path for WUR to become a top international university in the domain of life sciences and agricultural research in the Netherlands.

2. Foundation for building a green educational ecosystem at WUR

Since the late 20th century, in the face of climate change, the United Nations has set the millennium development goals, focusing on environmental and social issues. A number of the United Nations' forums on environment have been organized (Stockholm Conference, 1972); World Commission on Environment and Development (WCED, 1983); The United Nations Conference on Environment and Development, known as the Earth Summit (Rio de Janeiro, 1992). In September 2000, the Millennium Summit of the United Nations adopted the Millennium Declaration. In 2002, Agenda 21, an action plan of the United Nations, was discussed, supplemented and improved at World Summit on Sustainable Development in Johannesburg (South Africa), and the Millennium Development Goals on society and environment was perfected. In 2013, the member states of United Nations started

the process of achieving Millennium on Development Goals by 2015, and building a set of 17 sustainable development goals. Agenda 2030 with 17 sustainable development goals is formally approved on September 25th, 2015 at the Summit Conference of the United Nations with the participation of 193 member states. Agenda 2030 covers the universal, wide and comprehensive policy with 169 real objectives and 232 targets, in order to head for poverty alleviation, planet protection and to ensure that everyone enjoys peace and prosperity by 2030 (VPPA, 2017).

Confronting the global challenges over climate change and sustainable development, WUR determined its mission as "to explore the potential of nature to improve the quality of life" by means of training, research and new value creation. WUR's core activities focus on the field of healthy food and living environment with the three key areas: 1) society and well-being; 2) food, feed and biobased production; 3) natural resources and living environment. WUR's target is to train students to become prestigious experts and scientists to find sustainable solutions for complex issues in both the present and future in the field of healthy food and living environment in the world, seriously paying attention to society, responsibility for society and social morality (WUR, 2017)

WUR poses its above mission and targets based on the practical requirements for university graduates' various capacities to carry out their work in a strongly changing world. In order to meet the realities of life and to work in a flexible, analytical, reflective way, learners need training modern knowledge consistent with scientific progress and real life. Graduates can apply studied knowledge to work, to life and develop it much more. A sustainably developed society requires learners to be equipped with academic and advanced skills of the 21st century, to be critical, inquisitive and creative in thinking, to have ability to observe and judge, to have a great sensibility for politics and markets, to have a talent for analyzing reports, reading, writing arguments, discussing and cross-culturally, multiculturally cooperating … Specialized knowledge and skills help learners design and determine solutions for necessary matters combined with actual requirements to become "creative businessmen". Such knowledge and skills allow learners to analyze and evaluate effects of sustainable solutions towards human life, our planet, and economic prosperity. Learners' excellent qualities relating society help apply knowledge and skills in international interdisciplinary or cross-disciplinary, multicultural environment (WUR, 2017)

Deeply mastering the perspective on sustainable development, WUR encourages its students to become scientific experts and responsible citizens who respect their social responsibility and individual morality, apply and share skills in life learning, cooperate with related sides with the object of creating economic and social values; WUR's training contents are maintained in the direction of developing individual's leadership skills, especially those playing key roles in shaping future society. For achieving such results, WUR sets the principle of developing training programmes with three groups of knowledge: 1) scientific knowledge of high quality; 2) ample learning environment; 3) flexible individualized learning path.

With reference to high-quality scientific knowledge, WUR focuses on training doing research and new value creations. The graduates would be equipped with strong knowledge foundation, at least of a scientific discipline and basic knowledge from other disciplines. WUR' s students study scientific research methods through excellent researchers and concurrently join and experience specialists' own processes of research to develop their research skills. Not only does WUR pay attention to the combination between training and scientific research, but it is also WUR's main principle: furnishing students with knowledge on scientific research methods and outfitting students for understanding and well applying scientific research methods, mastering analytical and critical skills to pack in new value creation

In regards to ample learning environment, WUR centers on activating independent self-study attitudes and abilities, encouraging individualization to be in harmony with the diversity and the potential of nature of each student. The training programme focuses on real-life situations, where students can apply scientific and practical knowledge to solve complex and interdisciplinary problems. Practical environment is a tool to develop attitudes, behavior, social responsibilities, interdisciplinary, cross-disciplinary, multicultural collaboration, ability to respond to stakeholders and diverse social influences

Concerning individualized learning path, WUR builds full-time along with part-time training programme; forms the conditions for every student to create their own learning path, learning plan appropriate for learners' talents, tastes and abilities. The university provides freedom of choice in association with flexible guidance, feedback and control. The processes of creative study and research can take place inside, outside the university, online. The university encourages students to design and propose their courses and learning time WUR's targets, missions and vision are the basis for the University to design the smart green educational ecosystem, to create motivation for strong changes to help WUR rise and appear in a large amount of honorable World University Rankings

3. WUR'S smart green educational ecosystem

WUR's green educational ecosystem is developed and perfected owing to projects, programmes, plans, reports specifically including: 1) The development strategies to 2000; Building new creative learning ecosystem (2014) and report over educational ecosystem development in WUR (2015); 2) Project supporting growth (2014); 3) Programme on innovation of educational approaches in Wageningen (2014) and Plan of Activities of Work Group over philosophy of education; 4) Programme in the direction of multicultural education for international students; 5) Consulting report: International Bachelors (2016) and Pioneers (2017) (Arthur Mol, 2016).

3.1. Modelling and system designing

The global challenges are mastered in designing green educational ecosystem: 17 sustainable development goals of United Nations (Figure 1) (United Nations, 2015).

Fig 1: Global Challen ges and Sustainable Development Goals

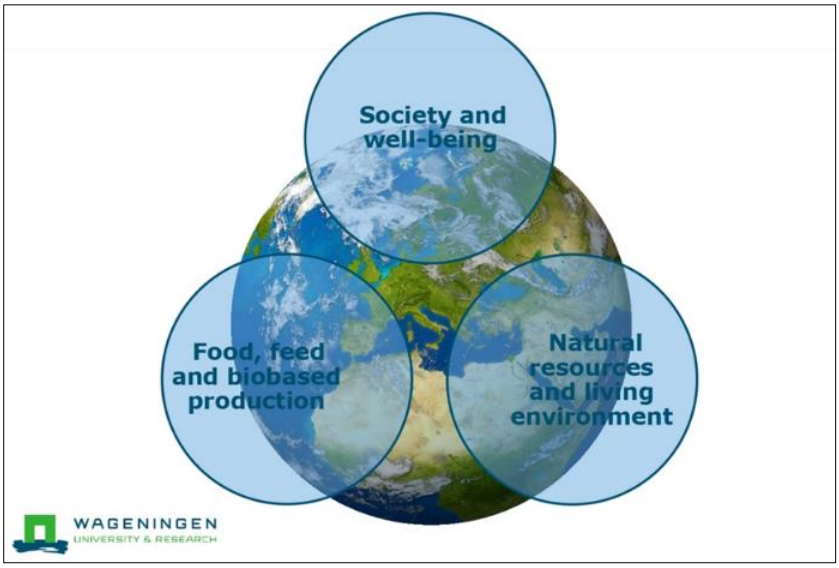

Fig 2: WUR's knowledge domains of changing world (Arthur Mol, 2016)

WUR's awareness of important issues in a developing world comprises: society and well-being, food, feed and biobased production, natural resources and living environment (Figure 2).

From awareness of global challenges and changes, WUR invented, analyzed, and designed the principle of innovation, a dual cycle including technological innovation and social innovation. The key components are integrated with innovation programmes comprise: food data, energy data, urban data, ecology data, water data, information data… To handle with To handle all the above issues, transdisciplinary scientific methods were applied, with the combination between the university and residents, consumers, companies and policy makers. Arthur Mol (2016) modelled the principle of designing WUR's development system as follows: (Figure 3).

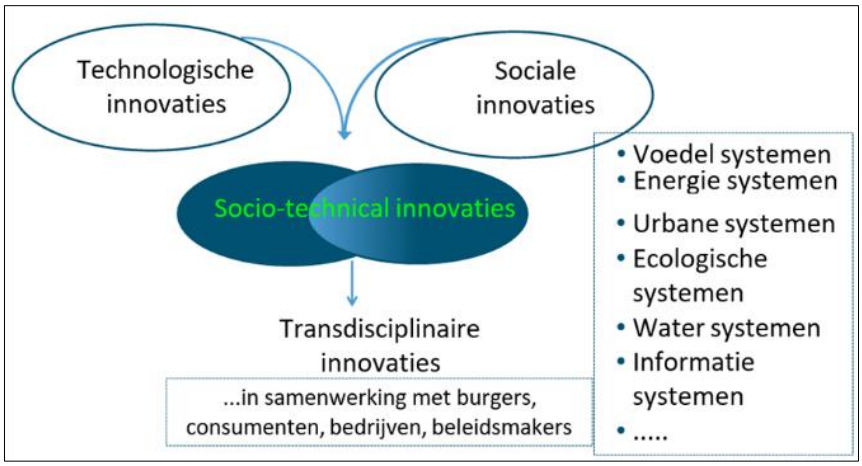

Fig 3: Modelling WUR's principle of development innovation (Arthur Mol, 2016)

From such principle of innovation, WUR developed educational ecosystem with four main components: distance learning system, smart campus, online learning system, open educational resources, all link and support each other in a unified whole.

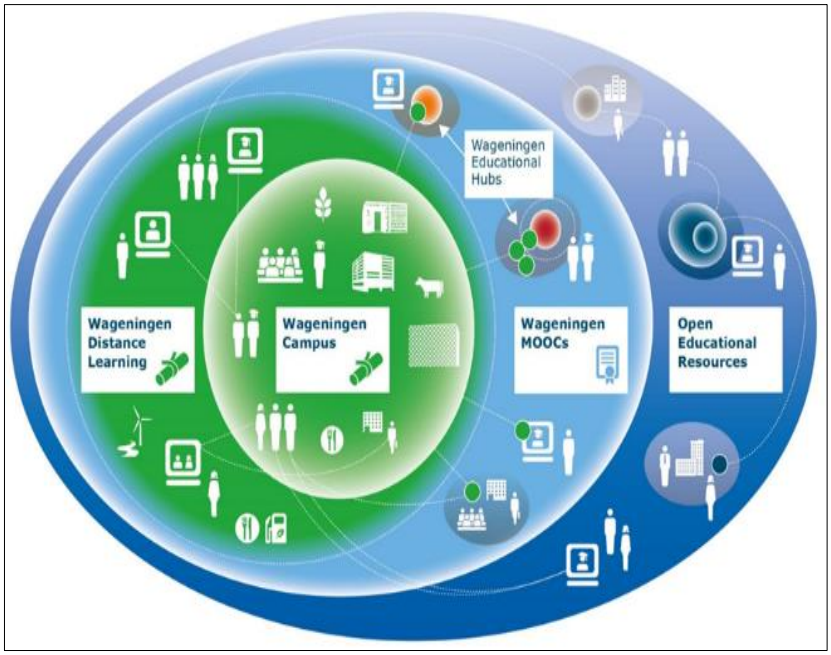

Fig 4: WUR's educational ecosystem (Arthur Mol, 2016)

Concerning scientific researches, WUR designed the research system rotating about its axis of core values: society, health and well-being, food and bio-based production, natural resources and living environment. Modelling research activities is generalized in Figure 5.

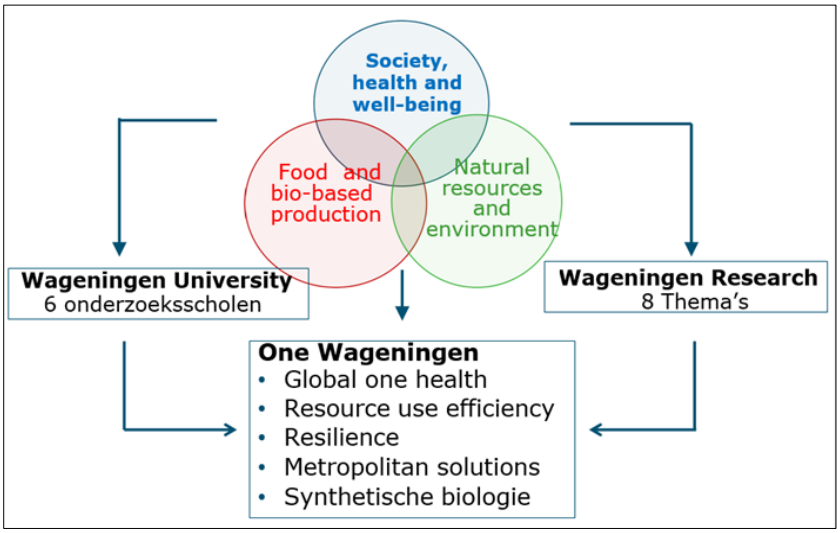

Fig 5: Modelling research activities at WUR (Arthur Mol, 2016)

3.2. Outstanding results

In regards to the strategy of developing green ecosystem, WUR achieves overwhelming development, becoming a training facility of university with Dutch characters. The training size is rapidly increasing, especially international students. In 2002, WUR had 4,571 students, of which 3,712 were Dutch students and 859 were international students. By 2022, WUR has 13,108 students, of which 9,956 are Dutch students and 3,152 are international students. About the program scale, WUR has 20 undergraduate programs, 32 graduate programs, and 45 open online courses. By 2022, WUR has 62,225 alumni, of which 45,995 alumni are Dutch, 5,900 from European countries and 10,330 from the countries outside the Europe. Wageningen University Fund possesses the presence of 3,402 sponsors.

Concerning the faculty scale, in 2002, WUR has 5,961 customary lecturers, of which 3,625 work at Wageningen Research Institute, 2,336 work at Wageningen University. By 2022, the total number of customary staff is 6,742, of which 3,327 work at Wageningen Research Institute and 3,415 work for Wageningen University. The rate of professors accounts for over 5% of the total number of staff and lecturers, the rate

of PhDs is over 35% of the total number of staff and lecturers; by 2022, WUR has 231 full-time professors and 77 visiting professors, and 58 expert professors and 2,389 PhDs work customarily.

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In reference to international collaboration, WUR cooperates with a number of different partners and associations such as: Association for European Life Science Universities (ICA), Food and Agriculture Organization of the United Nations (FAO). In the Netherlands, WUR cooperates with the partners: Amsterdam Institute for Advanced Metropolitan Solutions (AMS), Federation of the four Dutch universities of technology (4TU. Federation), OnePlanet Research Center, Strategic Association of Eindhoven University of Technology (Wageningen University & Research Center, Utrecht University, UMC Federation of Utrecht TO2 wetsus) At WUR campus, 213 organizations set representative offices including 158 small and medium companies (startups), 25 non-governmental organizations, 23 corporations. Wageningen campus is the most sustainable basis according to World University Rankings of Green Metric in 2022 (UI, 2022).

By 2023, WUR is ranked in 12 world university rankings such as World University Rankings, World University Rankings by Subject: clinical and health, World University Rankings by Subject: engineering and technology. WUR was ranked first in UI GreenMetric World University Rankings, named in the Academic Ranking of World Universities in health sciences (ARWU Life sciences), QS World University Rankings by Subject: Agriculture & Forestry (QS Agriculture & Forestry). WUR's rankings is listed in Table 1.

Table 1: General information on WUR's world university rankings

Nº	Organization to rank	WUR's university ranking	Time
	Ranked Best World University (UI, 2022; ARWU, 2022; CWUR, 2022; Leiden University, 2022; QS 2022b; THE, 2022a; USNWR, 2023)		
1	UI Green metric	1	2022
2	ARWU World	151-200	2022
3	CWUR World	178	2022-2023
4	CWTS World	64	2022
5	QS World	124	2023
6	THE World	59	2023
7	USNWR Global	89	2022-2023
	Ranked World University by Clinical and Health (ARWU, 2022; QS, 2022a; QS, 2022b; USNWR, 2023)		
8	ARWU Life sciences	1	2022
9	QS Agriculture and Forestry	1	2022
10	QS Life Sciences & Medicine	43	2022
11	THE Life Sciences	19	2022
	Ranked World University by engineering and technology (USWR, 2023)		
12	THE Engineering	97	2022

3.3. Identifying green university characteristics at WUR through some typical research and investment programmed

In accordance with the strategy of exploring the potential of nature to improve the quality of life, WUR's research and investment programmes aim to support the government, the commercial and industrial sectors as well as civil society to deal with the challenges in the direction of sustainable development. WUR's research and investment activities require a close combination of training with basic and applied research, deployment and transfer to governmental agencies and the community.

The focus and direction of WUR research are mapped out in a 4-year Strategic Plan. For the period 2019-2022 - with an extension and update until the end of 2024, WUR has identified five research programmes and six investment programmes (WUR).

Table 2 presents basic information on objectives and contents of five research programmes. These programmes communicate a signal to identify WUR's outstanding characteristics as a green university, originating from or related to sustainable development goals, for life and for human future.

Table 2: Objectives and Contents of 5 research projects period 2019-2022 at WUR (WUR)

No	Research programmers	Objectives and contents of project
1	Circular and climate-neutral	**Objective:** Transition of the circular usage of water, nutrients and carbon, in combination with a minimal loss of natural resources **Content:** Renovation of governance policy, developing tools for managing and monitoring transition in the direction of a circular and climate-neutral society; renovating primary production systems; transforming fossil-based products into security products, biobased products; building an environmentally friendly society
2	Food security and the value of water	**Objective:** Developing new pathway in the direction of sustainable food systems, shaping process of innovation for food security **Content:** Harmonious relationship between land and water, consumer's role and city-countryside relation,

		scenario, navigation and contribution in innovation; new discoveries of food security; transition towards sustainable food security
3	Nature inclusive transitions	**Objective:** Solving challenges related to biodiversity including ecology, agriculture, social sciences and economy **Content:** Discovering ecosystem functions at different levels, biotechnology and innovation methods in biodiversity measure and control, related sides in changing behavior and notion of activity in nature-inclusive society
4	Healthy & safe food systems	**Objective:** Developing knowledge to make food products more sustainable and healthier, to help better understand the implications of transition in food system over sustainability, health and safety-related issues, as well as to help better understand consumer behavior and choices **Content:** Increasing health through nutrition; nutrition, health and sustainability; food safety and traceability; risks emerging in food systems in transition.
5.	Data-driven and high-tech	**Objective:** Developing data-driven high-tech; data-driven and high-tech innovations to make food production; making high-tech breakthrough in food production, farming and horticulture more efficient and sustainable **Content:** Artificial intelligence based on data-driven analyses, robots to take decisions, infrastructure for knowledge sharing, making software to find out food pollution; smart software for consumer food choices; robots analyzing to provide correct methods for animal and vegetation

With reference to investment, from 2022, WUR have deployed six programmes: 1) Connected circularity (until 2022); 2) The protein transition (until 2022); 3) Digital twins (until 2022); 4) Biodiversity-positive food systems (2022-2024); 5) Transformative bioeconomies (2022-2024); 6) Data-driven discovery in a changing climate (2022-2024).

Similar to research programmes, WUR's investment programmes comprise the complete chain of knowledge, from basic research to discover the potential of nature to science-based and widened practical knowledge to create efficient and applied solutions (WUR)

In each investment programme, WUR determines the principles of approach to ensure the goal of sustainable development through some flagship projects. For example, WUR approaches the programme of Connected circularity (until 2022) on the basis of 3 leading principles: 1) Our circular food systems are built on plant-based biomass obtained from land and water; 2) Byproducts from plant-based biomass, known as waste flows, are to be avoided. If this is impossible, they must be redirected back into the bio-economy, with healthy soil as a priority; 3) The function and role of animals is to return biomass that is unsuited for human consumption into the food system.

This programme is deployed with 4 flagship projects: 1) Alternative futures of a circular bio-based society: the environmental and economic consequences of adopting circularity at different spatial scales (Van Selm *et al*., 2023) [24]; 2) Ensuring quality and safety (Berendsen *et al*., 202); 3) Collaborative design of transformative pathways towards a bio-based circular economy (Keesstra *et al*., 2022) [10]; 4) Circularity by Design (Van Dijk *et al*., 2022) [21].

Relating the programme of "The protein transition (Until 2022)", WUR develops ground-breaking knowledge and technologies for the purpose of accelerating the protein transition.

With emphasis on optimization of protein production systems to deliver benefits for sustainability, cost and equity, WUR endeavors to direct to zero waste, upcycling proteins for maximum use, increasing the total protein supply without any additional resources. In optimal system, the competition between food and feed is removed and all the fitting sources in direct consumption are applied in food

The unfitting resources for human consumption can be upcycled with the use of microorganisms, insects or other animals. WUR rates this programme very important for benefits towards environment, for zero hunger, for resilience and for public health.

In general, the objective of the programme is to make transitions in the direction of a sustainable protein system. WUR asserts that the protein systems in the future will include a wide variety of diversified proteins.

The plans will be adjusted suitably for regional resources based on the availability (Or scarcity) of fertile land and water. In Europe, pulse and grain production will be increased as a result of successful breeding programmes. Resource-independent protein production systems applying fermentation, microalgae or aquatic crop will ensure global food security in opposition to accelerating climate change (WUR)

4. Conclusion

Global warming, loss of biodiversity or plastic pollution in seas are global environmental issues that are threatening life on Earth. Today, these challenges have negatively impacted production and human health. As a research and training organization, WUR has established its mission, vision, goals, and plays an important role in engagement in solving these global problems.

This confirms why it is important for WUR to become a green university and shows that WUR understands its pathway and is ready to deal with the challenges of higher education in the new era - the global era centering on sustainably economic and social development based on state-of-the-art knowledge and technology. In WUR's green educational ecosystem, environmental benefits and sustainability are two eminent characteristics; activities in training, research, scientific and technological transferal all strive for green and environmentally friendly goals. With the strategy of green education development, WUR has established its ability to lead smart universities in the Netherlands.

Green university developed at WUR is one of the models of a university that aligns its activities with the United Nations' sustainable development goal. The historical core values (training and scientific research) have been combined with "participation in society", the third core value that is more modern. All these three core values have been communicated to policies, actions, and joint efforts with stakeholders and the community in the process of school and social improvement towards the principles of developing sustainability and combating climate change. By means of prompting and developing new ideas and improvements, WUR motivates energy and water conservation, organic food production,

recycling waste and green transport. Not only have such activities taken direct part in the United Nations' millennium goals but they also have had indirect impacts and changed behavior as well as economic, social issues related to sustainability. That is really the path for WUR to become a model for society and important partner for the government.

Green university developed at WUR represents the trend of universities' participation in society. WUR demonstrates a model of university as an open system. WUR has developed its open academic system for scientists, local community and society at large to become part of it.

The interplay between schools, businesses and society has become a lively environment for spreading ideas, knowledge and human needs. WUR has truly become a facility providing solutions for social issues. WUR's proposed solutions are implemented together by students, faculty, businesses and the community members; in which WUR plays the central creative role due to advanced technology and its scientific research results. WUR's activities with the aim of offering creative solutions for economic and social issues help WUR connect much more with the locality, the community and society.

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