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Agricultural higher education in the 21st Century: Non-traditional educational models

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I – Introduction: The status of the agricultural economy and the challenge of human resources

According to IFAD (2012), "there are about half a billion small farms in the world, supporting around 2 billion people and [the] food production needs to be doubled by 2050 in developing countries to assure food security. GDP growth generated by agriculture is up to four times more effective in reducing poverty than growth generated by other sectors".

In spite of its critical role, the trend in the agriculture sector has been a decline in terms of its contribution to Gross Domestic Product (GDP). The biggest slump can be seen in South Asia, which pioneered the Green Revolution in the 60's. The sector's contribution of 34.7% during the 80's came down to 18.5% during mid-2000's and similar trends were visible in other regions (Khilji, 2012). Such a decline in the contribution to GDP has not been accompanied by a concomitant decline in the sector's workforce. The share of agricultural employment, though reduced, still stood at 48% in South Asia, 38.4% in East Asia and 64.7% in Sub-Saharan Africa during 2007 (ILO, 2008).

An economic sector which employs 35 to 65% of the workforce, but only contributes 12 to 19% of the GDP, raises key questions. Disguised unemployment, under employment, and low or nil productivity imply that the sector needs a serious reconsideration in terms of investment and human resource development without which issues such as poverty eradication cannot be addressed. However, the investment seems to be decreasing substantially and according to FAO: "Between 2001 and 2012, the average national share of government expenditures on agriculture, forestry and fishing (GEA) fell almost 30%, from 3% of total government expenditures to just over 2%" (FAO, 2015). While the major portion of the farm investment comes from the farmers, the investment on research and extension has been mostly from governments. Thus the agriculture sector is characterized by high dependency on the state in terms of employment, investment, and the need to increase the production and productivity. Education, particularly higher education in agriculture, has been one of the causes and effects of this paradox.

II – History of agricultural higher education in developing countries

The colonial system influenced the development of education in many developing countries. The traditional style of indigenous education was transformed into an institutionalized form which provided a link between primary, secondary and tertiary education through schools, colleges, training institutions and universities. The brick and mortar, didactic mode of education began during the 19th century in many developing countries as an important tool for economic growth and social development.

Many Asian and Latin American countries witnessed a growth in higher education in agriculture during the nineteenth and early twentieth centuries. In contrast, Africa had a late start. The shift from extraction-oriented industries to production-oriented economic strategies by the colonial powers in the early 20th century led to the establishment of educational programmes for imparting technical skills to the local populations. While countries like South Africa and North African countries like Algeria had university education before World War I, the rest of Africa had to wait until the 20's and 30's before higher education institutions were introduced.

Post-secondary education in agriculture began in Makerere University in Uganda as a certificate course in 1924 and it was not until the 1960's that the large scale development of agricultural higher education took place in Africa. Between the 1960's and 1980's, around 20 universities introduced faculties of agriculture and veterinary sciences every decade (Beintema *et al*., 1998).

III – Challenges in agricultural higher education

History, resource constraints, ideologies and polices have affected higher education particularly in Africa. Bloom *et al*. (2006, p. ii) point out that the development of tertiary education was neglected due to the belief of the international development community that primary and secondary education were more important for poverty reduction. Within tertiary education, agriculture had been relegated to a lower status. Agricultural research and extension cannot mature without appropriate human capital trained at a tertiary level, and such a process requires adequate investment. Public spending on agriculture as a share of agricultural GDP in many Sub-Saharan countries at 4% was significantly lower than that of the transforming economies in East and South Asia which spent 10% during the agricultural growth spurt in the 1980's. The New Economic Program for African Development (NEPAD) has advocated an increase in agricultural spending to 10% of the national budgets to strengthen Africa's agriculture sector (Staatz and Nango Dembélé, 2008).

Lower investments have affected the availability of skilled human capital in African agriculture. While lack of adequate data does not given an exact picture, the trend seems to be clear. There are only 42 researchers per one million persons economically active in agriculture in Africa which is hardly 2% of the scientist-farmer intensity in the developed world (Ayre and Callway, 2005). There seems to be a similar trend in agricultural extension. Studies in Africa show that in Ghana, only 12% of male-headed farm households and 2% of female-headed farm households have access to extension services (Curtis, 2013). The research-extension-farm linkage is weak due to inadequate financial and human resources. The downtrend in agricultural higher education has affected this linkage to a great extent. An analysis of the tertiary enrollment in some selected Sub-Saharan countries reflects this concern (Table 1).

The lower enrolment in agriculture and the declining share of agriculture in total enrollments are the outcome of several factors. The excessive dependence on public sector employment, limited opportunities in private sector employment and the substantial fee and opportunity costs deter many students from joining tertiary agricultural courses. The recent increase in the private sector involvement in agriculture has started influencing skilled workforce absorption. Quoting a government report, the National Academy of Agricultural Sciences (2014) in India, points out while the targeted training capacity by 2022 is 20 million, the present system can only absorb less than 2 million per annum. Singh (2013) in his presidential address in the National Agricultural Science Congress during 2013 points out that while India produced 24,000 agricultural studies graduates during 2010, the projected requirement is 54,000 by 2020 necessitating a two fold increase in institutional capacity. Affordable access is a key challenge.

The quality of education is another major concern. A study on the skills, strengths and weaknesses among agricultural graduates in Botswana, Lesotho and Zambia shows that there is a gap

Table 1. Tertiary education and share of agriculture in Sub-Saharan Africa

Country	Total enrollment in tertiary education			Total enrollment in agriculture/tertiary level			Share of agriculture in total enrolment %	Annual growth % in the share of agriculture in total tertiary enrolment††
	Year†	Number	Annual growth %	Year†	Number	Annual growth %		
Burkina Faso	1999-2007	33,459	30	2007	321	–	1	–
Ethiopia	1999-2007	210,456	38	1999-2007	17,884	33	8.5	-0.1
Ghana	2000-2007	140,017	22	2000-2004	3019	8	4.3	0
Kenya	2000-2004	102,798	4	2000-2001	6969	5	7.4	-0.1
Malawi	1999-2007	6,458	13	1999	490	–	15.4	–
Sierra Leone	2000-2002	9,041	17	2000-2001	1360	315	15.3	10.4
Tanzania	1999-2005	51,080	15	1999-2005	2417	15	4.7	-0.3
Uganda	1999-2004	88,360	24	1999-2004	1403	11	1.6	-0.1

– not available.

† Earliest and the latest year for which data are available.

†† Years are the same as for agricultural enrolment.

Source: AGRA (2013, p. 131) based on http://stats.uis.unesco.org

between the employer's expectations and the performance of the graduates (AGRA, 2013). Skills relating to markets, financial management, communication and leadership are deficient among these graduates indicating a 'serious disconnection between …the tertiary agricultural education and the needs of the industry' (AGRA, 2013, p. 131). A study analysing 3,439 organizations employing agricultural graduates in India, indicate a gap in skills of about 75% at the graduate level and 70% at the post-graduate level (Rama Rao *et al*., 2011). Sumarti (2010, p. 151) refers to a similar trend in Indonesia where 'the image of agriculture and agricultural higher educational institutions –is declining posing a serious threat to agricultural development'. While governments have been supporting in-service training to strengthen the quality of services, its impact on the performance of the agricultural graduates is yet to be fully realized.

Even though Asia had an earlier start in terms of the green revolution, it continues to face the challenge of insufficient human resources. In India, the public expenditure on research and development of US$0.40 per US$100 of agricultural GDP is low compared to BRIC countries like China and Brazil and much below the developed countries such as Japan and South Korea (Kumar and Sinha, 2014). With the exception of Bangladesh, a declining or stagnating trend in agricultural research intensity can be seen in countries like China, Sri Lanka, Vietnam, India, Pakistan, Indonesia, Philippines, Malaysia and Nepal (CAPSA, 2015). Similarly in extension, it has been estimated that there are around 60,000 extension agents in India with one extension agent supporting 5000 farmers whereas in China with 800,000 extension agents, one extension agent supports 625 farmers (IFPRI, 2010). The challenges in agricultural tertiary education are the causes and effects of lower research and extension intensity which in turn contribute to the relatively poor performance of the agricultural sector.

A twofold increase in quality agricultural education will require substantial financial resources. Globalization, structural adjustments and various economic crises have influenced many developing countries to review the role of subsidies in the economy reducing the investment in agricultural education. Recently, India allocated USD73 Million to establish 12 new Central Universities. According to Altbach and Jayaram (2009), "one large research-intensive new Chinese university costs around US$700 million to build and has a total annual budget of close to US$400 million). Altbach (2004) estimates that the cost of creating a world-class university would be around 500 million dollars. Given the cost of establishing campus-based institutions, very few countries will have the financial resources to set up new institutions to absorb the growing demand.

To sum up:

- Agriculture is vital for sustainable development.
- Public investment as well as private investment in agriculture can increase agricultural production and productivity and reduce poverty. At present there is inadequate investment in agriculture and even these investments are declining.
- The declining investments have affected the research-extension-farmer linkage with low research and extension capacity.
- Tertiary agricultural education has not been able to supply the numbers of skilled and knowledgeable workforce required to support agriculture, due to historical factors, economic challenges and financial constraints.
- The conventional didactic mode of education promoted by the university system is inadequate to meet the demands of human resources in agricultural sector.

Hence a paradigm shift is required in approaching tertiary agricultural education. What are the options?

IV – Non-traditional Educational Models

As governments and policy makers seek to expand access to education, reduce costs and improve standards, it is clear that alternative approaches are needed.

In the previous decade we have seen an unprecedented demand for higher education. In 2007, there were 150 million tertiary students globally, a 53% increase over 2000. The number increased to 165 million in 2012 with an estimate that this is expected to rise to 263 million in 2025 (Altbach, Reisberg and Rumbley, 2009). If the children who will reach enrolment age between now and 2025 are to be accommodated, four universities with a capacity of 30,000 will need to be built every single week.

In the current economic climate, traditional brick and mortar solutions will not be enough. Four developments emerged as a response to the growing demand for affordable quality education, which have significant relevance for agricultural institutions as well.

This rising demand for higher education gave rise to a new type of provider – the distance education institution. The success of the Open University UK captured the imagination of policy makers around the world but particularly in developing countries.

When the Open University UK was established in 1969, the notion of ‘openness’ was a significant innovation. Lord Crowther, the founding chancellor of the Open University of the UK’s statement of openness in relation to people, places, methods and ideas forms the basis of throwing open the ivory towers of higher education (Perry, 1976).

Open universities were oriented towards the massification of higher education. Many open universities do not insist on entry qualifications, allow learners to accumulate credits at their own pace and convenience and are flexible enough to allow learners to choose the courses they wish to study towards their qualification.

The new ideology was that learning could take place without a teacher and self-instructional materials were developed to cater to the diverse needs of the learners. There was a greater use of radio and television to supplement print materials. The learner was seen as a consumer – which was a major shift in ethos.

In 1988, there were only 10 open universities in the Commonwealth – 3 in Canada and only one in Africa, that is the University of South Africa (UNISA). Twenty five years later, in 2012, the number of open universities in the Commonwealth has increased to 28.

Why are open universities so popular? One reason is lower costs. The annual cost per student at the Korean National Open University is $186 as compared to nearly $3000 for a campus student. Similarly the costs for STOU students are $226 compared to $876 in a campus university (Perraton, 2000).

A study by the National Knowledge Commission (NKC), India, shows that mega-universities, which achieve economies of scale, cost substantially less than campus institutions. Pakistan's Allama Iqbal Open University (AIOU) costs 22%; China 40%; India's Indira Gandhi National Open University (IGNOU) 35%, and the Open University UK (OU UK) 50% as compared to campus universities (NKC, 2004).

What of quality? In 2012, the Open University UK ranked first in student satisfaction. In addition the OU UK ranked fifth among the 100 universities surveyed by the Quality Assurance Agency (QAA) in the UK and was one rank higher than Oxford University.

In the developing world, India has developed a national policy for distance learning and has established 17 open universities which cater to 23% of all enrolments in higher education. Here is an example of a developing country using a non-traditional approach to provide access to education for millions of its young people.

The agricultural education sector has been slow to take advantage of open and distance learning as a means of increasing access, improving quality and cutting costs, however examples do exist. In India, the Yashwantrao Chavan Maharashtra Open University (YCMOU) started its School of Agricultural Sciences in 1993 and has continually maintained its certificate, diploma and bachelor degree programs in horticulture. The Indira Gandhi National Open University (IGNOU) launched its School of Agriculture in 2005 and offers certificate, diploma, as well as doctoral programs. Among land grant universities in the United States, the Soil and Water Science department of the University of Florida pioneered offering degree programs in distance mode during the last decade. A number of other land grant colleges now offer degree programs in agriculture by distance.

With increased access to technologies, there is an increasing trend towards online learning, especially in developed countries. In 2013, almost all public institutions in the United States were offering online courses. In the same year, over 33% of all US higher education students were taking at least one online course (Allen and Seaman, 2014). After North America, Asia has the highest growth rate with developing countries like Myanmar, Thailand and Malaysia leading the continent in eLearning (Ambient Insight Research, 2013). According to the Babson Survey more than 80% of students considered online learning outcomes comparable with face-to-face, with over a quarter considering them superior (Allen and Seaman, 2014).

The first web-based course appeared in 1995 in Canada, a technology-based innovation in open and distance learning. Online courses brought in innovations such as authoring tools, learning management systems, unlimited web resources and online self-tests, which introduced a greater scope for interactivity. With the rise of social media, there has been a global movement towards collaboration in the development and sharing of content, which is concurrent with the rise of Open Education Resources (OER). The fundamental principle is that any materials developed with public funds should be made available freely to others.

OER are educational materials which are free and freely available, are suitable not just for higher education but for all levels, including primary and secondary education. OER can be reused and repurposed to suit different needs and can be made available in any format, including print, audio,

video, and digitally. A key difference between OER and other educational resources is that OER have an open license, allowing for adaptation and reuse without request to the copyright holder.

The Commonwealth of Learning (COL) convened the World OER Congress with UNESCO in 2012. The declaration resulting from this congress has led to greater awareness about OER and its wide scale adoption. Several advantages of OER are identified and described (Kanwar *et al*., 2010). Two are particularly significant here. One is the adoption of open licensing, which allows potentially massive numbers of users to derive a direct benefit in terms of unrestricted access and use of high quality learning materials. The open licensing of software, which is an older and similar practice, has led to the availability of key information services at zero or affordable costs (an example is Wikipedia, which shares both its content and software under an open licensing regime).

The emerging use of open textbooks in parts of North America has led to the availability of good quality textbooks that come at zero cost to students (https://openstaxcollege.org/books). In the US, under the Utah Open Textbooks project, an OER-based textbook can cost as little as $5, or if accessed online, can be entirely free (Wiley *et al*., 2012). In another study of open textbooks Robinson, *et al*. (2014) found that students who used open textbooks scored 0.65 points higher on end-of-year state standardized science tests than students using traditional textbooks. A similar study published in *American Economic Review: Papers and Proceedings* in 2015 revealed that US colleges are charging lower fees for online course materials, suggesting that online education is "bend[ing] the cost curve" in higher education (Deming *et al*., 2015).

At the same time, a reasonable quantity of good quality digital learning material has been published online without an open license, rendering them ineligible as OER. The National Agricultural Innovation Project (NAIP) in India for example has produced course materials for 475 undergraduate courses covering six core areas of agricultural science, equivalent to about 15000 hours of classroom instruction (*ICAR, 2015)*. While this large collection of resources is in a digital, shareable format, access to them is limited by network firewall, and only possible for users with authorised credentials. The Jing Pin Ke (www.jingpinke.com), National Top Level Courses project of the China Ministry of Education is another example where learning materials are being shared, but not in a format that would qualify them as OER. Jing Pin Ke's 259 undergraduate courses in Mandarin are open for browsing, but do not carry an explicit open license.

A substantial quantity of higher education materials in the agricultural sector are not published online at all. The question of open licensing comes later. There is only one known example of an Open University publishing agricultural learning materials online (www.agrilore.org). This is a collection of learning material presented as 506 learning objects, as opposed to full courses, on topics relating to horticulture for smallholder farmers. Even here, the licensing arrangement under which they are shared is unclear.

There is a clear need for strong advocacy in the use of OER in agriculture, for building capacity among faculty who can produce online learning materials, and for the use of open licensing in publishing them. This is a need that is common to developed, as well as developing countries. A major effort by 20 institutions in developed and developing countries to create graduate courses online and to publish learning materials as OER was proposed in 2008 but received no support (IFPRI, 2010). Efforts such as these must be renewed and pursued vigorously. Large scale national efforts such NAIP and Jing Pin Ke should be encouraged to publish learning materials online with a suitable open content license in order to facilitate the reuse of these high quality learning materials.

What implications does this have for pedagogy? Terry Anderson terms the focus on networks and collaboration as 'connectivism', which places emphasis on collaboration rather than competition. The learner's role becomes more significant here, as it shifts from that of a passive consumer to an active producer of content.

Related to this shift is a fourth major trend, which has emerged partially out of the growing use of free content and OER. This is the Massive Open Online Course (MOOC), a form of distance and online learning. Started at the University of Manitoba in 2008, MOOCs gained traction in the ivy league institutions of the United States and have resulted in major consortia of top universities on both sides of the Atlantic: Coursera, EdX and Udacity in the US, FutureLearn led by the OU UK, and many others around the world. 2012 was declared by the international media as the year of the MOOC.

One of the common motivations for adopting MOOCs in developing countries is the democratisation of access to higher education. The Malaysian Minister of Education has encouraged institutions to leverage new opportunities presented by MOOCs to democratize access to higher education (Nordin, 2015). The Indian government is also seeking to use MOOC platforms to reach segments of society which are difficult to reach via traditional means, including the working class and women (Saath and Vikas, 2014).

The Commonwealth of Learning (COL) offers *MOOCs for Development* (MOOC4D), which are specifically oriented toward learners with modest exposure to online learning practices. MOOC4D offerings make use of platforms and technologies that work in low bandwidth scenarios, and are compatible with offline learning activities that are not affected by network instability. In developing countries, MOOCs offer a new way of providing cost-effective, structured guidance and information around socially critical topics such as health, education and political governance, as well as others with similar social relevance. This is how MOOCs are relevant in the food and agriculture sector.

A survey of MOOCs catalogued on *MOOC List* (https://www.mooc-list.com/) that are currently being offered via platforms such as *Coursera* shows that MOOCs on agricultural topics constitute an insignificant fraction (less than six out of about 3600). There is a need for MOOCs to build awareness among farmers about essential practices that are sound, ecologically and economically. To understand the perception and views of leaders of agricultural education and research community, COL organised a brainstorming event with the National Academy of Agricultural Sciences (NAAS), India on the viability of MOOCs in agriculture. The overwhelming opinion was that MOOCs were viable in agricultural education and training (NAAS, India, 2014).

COL has offered two MOOCs covering students and faculty in agricultural universities as well as smallholder farmers who contribute to bulk of the food production in sub Saharan Africa and South Asia. The MOOC for gardeners in India was unique in many ways. A gardener or “mali” (in Hindi) is a semi-skilled farmer who normally owns little by way of land and water assets. This group of farmers contributes much to horticultural and floricultural production (Anderson and Dron, 2011). Since this group has practically no access to the Internet and is likely to be unfamiliar with online learning, COL’s partner, the Indian Institute of Technology-Kanpur (IITK), built a complete suite of MOOC technologies to enable access to learning materials using a basic, voice-only cell phone. The content of this MOOC comprised sets of audio clips on farming practices related to 22 select fruits, vegetables and flower crops. These practices covered all aspects of cultivation from sowing to harvest. The content team comprising four agricultural scientists reviewed available information, including the *Handbook of Horticulture* (ICAR, 2010) and the *Krishi Gyan Manjusha* (Uttar Pradesh, 2012) used at the national and provincial levels as official sources of horticultural information The total duration of all audio lessons was 2 hours and 13 seconds. Each topic related to a given crop had a set of audio clips, with each clip an average duration of 15 to 60 seconds. A key aspect of this course was the availability of a call center operated by the course team. The call center was functional from 9:00 am to 10:00 pm on all days of the course. Most calls were received after 5 pm. The course team provided callers with information on how to use the services, and how to appear for examination, in addition to providing solutions if service-related problems were being faced.

A comprehensive survey of learners showed that most were 25-29 years of age, and their education level was mostly limited to secondary school. The learners ranked the content as high quality

and relevant. At least some of the practices taught were applied almost immediately in the field. Learners appreciated the conciseness of the lessons, the clarity of voice, and the weekly quizzes. A total of 1055 individuals signed up via their cell phones, and about 65% remained active throughout the course. A total of 296 learners were eligible to receive certificates of participation. COL has also offered a MOOC on ICT basics designed for an audience that is predominantly from the milieu of agricultural education and research institutions. A total of 1893 learners enrolled with about 1260 remaining active throughout the six-week course. A survey of these learners showed very high levels of satisfaction with the topics and content presented. There is a demand for more courses like this one. Through these offerings, COL has been able to demonstrate that MOOCs can effectively meet the learning requirements of diverse stakeholders in the food and agriculture sector.

MOOCs mark yet another shift in teaching and learning by putting greater responsibility on the learner to construct knowledge through peer to peer interactions, and by shifting from teaching a small class to a massive group around the world. Will MOOCs transform the teaching and learning process? A significant difference is the emergence of the flipped classroom as the standard practice. There is a greater emphasis on peer-to-peer learning. The use of learning analytics, a component of the MOOC platform, can help collect and analyse data about how learning is taking place. Because of this, predictive systems can be developed to identify potential dropouts and provide the necessary support to help them overcome their difficulties. It can also highlight those areas where many students struggle so that the tutors get the feedback to take remedial measures.

V – The way forward

Distance and online learning have grown and evolved considerably over the last fifty years, keeping pace with, and taking advantage of various technologies that continue to emerge. Distance and online learning has also opened up access to millions of learners and is today a viable option for addressing issues of access, cost, equity and quality. While higher education institutions have taken advantage of these trends, the agricultural sector needs to deploy these non-traditional educational models. Developments in technology will serve to leapfrog to emerging developments.

What are the emergent trends of the future? The NMC Horizon Report (Johnson *et al*., 2015) estimates that in the next two years, social media will be ubiquitous and there will be a convergence of online and hybrid learning. Over the next three to five years, the availability of huge masses of learner data will make it possible to analyse this for continuous improvement and better outcomes. Learners will become creators of their own learning processes.

While professional education such as engineering and medical education are rapidly adopting distance and blended learning, agricultural education institutions in developing countries have yet to optimise opportunities and models that technology is currently providing. Though a small number of universities have started distance learning in agriculture, protocols and standards for quality assurance are yet to emerge. Policies and programmes oriented towards ODL, OER and MOOCs have the scope to address the issues in agricultural education, if they are adopted to suit the conditions of the developing countries.

The following steps can be considered:

1. Agricultural universities can adopt ODL and online provision to expand access and cut costs. By becoming dual mode, campus based institutions can offer two streams of provision that provide flexible options to learners, who can study at their own pace, place or time. In this case, ODL can supplement and complement rather than replace existing institutions and models.

2. When making this transition, policy makers would need to take a holistic approach. Rather than introduce ODL as an add-on, there would be a need to review existing policies and systems to inte-

grate the approach for optimal efficiency and effectiveness. One key dimension would be capacity building of all levels of staff to take ownership of ODL and to contribute to its effective delivery.

3. ODL and online provision can contribute to the ongoing professional development of the agriculture community and institutional personnel as well as provide opportunities for lifelong learning in this critical sector.

4. Agricultural universities need to embrace openness in a systematic manner. This would include adopting and adapting OER as well as open access policies for sharing and collaborating on research locally and globally.

As the international community gets ready to adopt the Sustainable Development Goals this year, the agricultural education community will need to adopt non-traditional and innovative approaches for human resource development if Goal 2, which aims to "end hunger achieve food security and improved nutrition and promote sustainable agriculture" (UN, 2014) is to be achieved by 2030.

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