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Amit Anil Shahane
Assistant Professor (Agronomy),
College of Agriculture, (Central
Agricultural University, Imphal),
Kyrdekulai, Meghalaya, India

Status and interventions in agronomical education at graduate and post graduate level in agriculture

Amit Anil Shahane

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Abstract

Agricultural education playing pivotal role in education system in India due to increase in accountability of all sort of agricultural knowledge (traditional, conventional, indigenous and modern) in formal education (example natural farming education), climate change related threads to food and nutritional security, increase in awareness about need/ scope of agricultural education and degradation of natural resource base. Agronomy being an applied and behavioural branch dealing with principles and practices of soil, plant and water management has to play significant role. Its significance in agricultural education is highlighted by highest credit hours allocation at graduation level, number of seats allocation for master degrees and multi-dimensional research themes with wide research and different minor subjects being opt at doctorate level. Considering the changes in challenges over the time (One health concept, degrading natural resource base, climate change, conservative and traditional farming, demographic changes and constraints and consideration of resource/ fund allocation) and being dynamic discipline, agronomical education need interventions. The present status of graduate and post graduate education as well as major interventions expected has been discussed in this article. The article in nutshell emphasized the importance of interventions in agronomy education by providing 25-30 point agendas of such interventions both at graduate and post-graduate level.

Keywords: Credit hours, agronomy, education, interventions.

Introduction

The agricultural education in India is keeping pace with development as well as other form of formal education and role of agricultural education is expected to increase in future. This is justified from fact about decreasing share of population (for employment) depending on agriculture (63% to 40% in last 25 years, increase migration of rural population to urban area (which are actively involved in agriculture) and increased climate and weather related variation. These demographic and agro-climatic changes demand knowledge intensive agricultural practices with skilled workforce. The demands for provisional services are ever increasing with bias of changes in food habit and agenda of nutritional security (raised by malnutrition concerns). For meeting these demands from finite resources, there is need for technological shift at different levels in agriculture which can be addressed through formal agricultural education. The implementation of National Education Policy through modification in agricultural graduate degree programme through VIth Dean Committee Report is one such recent example. With the arable area of 145 million ha (second largest in world), varied and suitable agro-climatic conditions for cultivation of varieties of crops and decreasing carrying capacity of natural resources due to extractive farming underpins the role of agricultural education and research systems. The natural resource bases being acted upon by input addition and management for generating productive good and services is major agricultural activity. The degraded resource base such as soil, plant (narrowing down genetic bases and reduced crop diversity) and water, their use efficiency as well as pollution leads to reduce effectiveness of input applied which need modulation of management practices. This need of modulation will further emphasize the significance of agricultural education. As the natural resources are basic resources, their management will be requiring at most attention for which natural resource management as discipline and Agronomy as subject will have to play important role.

Corresponding Author:
Amit Anil Shahane
Assistant Professor (Agronomy),
College of Agriculture, (Central
Agricultural University, Imphal),
Kyrdekulai, Meghalaya, India

The agronomy is applied and behavioural branch of agricultural science dealing with principles and practices of soil, plant and water management. The development of new inputs and practices, modulation of crop cultivation practices, changed response of crops/plants to input and management due to degradation of natural resource base and changes in consumer preferences and food habits indicate dynamics required in agronomical research and education which addressed by word “behaviour”; while need to incorporate knowledge generated by different disciplines for successful management of natural resources for crop production will address the word “applied” in agronomy definition. The dynamism needed in agronomical education and research can be also judged from the extent and diversity of changes occurred even after triode of green revolution (HYV, agrochemicals including fertilizer and irrigation infrastructure). These includes diversified farming practices such as conservation agriculture and different tillage concepts, organic farming, natural farming, changes in crop establishment methods and cultivation methods, additional of new dimensions in crop production such as crop residue management, integrated management approaches (INM, IPM, IWM and ICM), micronutrient fertilization (including agronomic biofortification), exploring and utilizing the rhizospheric microbial diversity, system of crop intensification (including SRI), precision farming practices (for N management through LCC and chlorophyll meters and laser land levelling), genetically modified crops and cultivation practices of these crops, micro-irrigation practices, development and evaluating climate resilient practices in crop production and so on. These all developments are knowledge intensive and dynamic with respect to space and time dimension. For handling of changes require skilled and technologically updated man powers and technical knowhow where formal agronomy education will play important role. Considering the significant of agronomical education in natural resource management and scope created by modified practices and new challenges (Figure 1), there is need to discuss the overview of agronomic education, changes over time, interventions/ modulation in agronomic education and research and potentials and consideration of agronomic education.

Agronomic education at graduation level

Agronomy at graduation level has highest weightage in terms of sources offered and credits hours across the last three Dean Committee Reports (DCR) (Table 1). This can be justified from numbers of credit allocated for agronomy which are 22, 28 and 22 respectively in IVth, Vth and VIth Dean Committee Report (DCR). In case of IVth to Vth Dean Committee Report (DCR), inclusion of “introductory agro-meteorology and climate change”, “agricultural heritage” and “geo-informatics, nano-technology and precision farming” as new compulsory sources as well as removal of “water management including micro-irrigation” are the major changes take place. Besides that course of “weed management” was made elective in Vth DCR which was compulsory course in IVth DCR (Anonymous 2007; Anonymous 2017) ^[1, 2]. In case of VIth DCR, four courses were introduced as elective courses each having 4(3+1) credits (Table 1). Introduction of farming based livelihood system, water management, weed management and introduction to forestry as core course and removal of “agricultural heritage” course are other major changes in VIth DCR over Vth DCR (Anonymous 2024; Shahane and Shivay, 2024; Shahane, 2024) ^[3, 6, 4]. Besides that, inclusion of principles and practices of natural farming and skill enhancement courses and up gradation of different courses

such as “crop production technology (practical crop production is merged in to this course), “geoinformatics remote sensing and precision farming (4 credit elective course which was earlier 2 credit compulsory course) and principles and practices of organic farming/ conservation agriculture (increased credit from 2 to 4 and making is elective course) also major shift in agronomical courses. The skill enhancement course has allocated 12 credits (all being for practical) with total six courses. The topics of skill enhancement courses related with agronomy are organic production technology, agricultural waste management, soil, plant and water testing and seed production technology. This indicates the development of skills in different related branches of agronomy given importance and hence the up gradation of faculty themselves with acquiring expertise in different aspects of input production, values addition and extending the vision beyond crop production and natural resource management in much needed in future. The development of separate degree programme on Bachelor of Science in Agriculture (Honours) Natural Farming further creates opportunities for the development agronomical education in graduate degree programmes (Shahane, 2025) ^[5]. As the natural farming getting acceptance and being promoted enthusiastically by different pioneer workers across India, its inclusion in formal education is worthy. This also facilitates the retention of large number of indigenous technical knowledge with attention to developing such knowledge to scalable technologies and promotes the variety of activities related with traditional knowledge. The traditional knowledge helps in making agriculture a self-reliant and helps in reducing dependence on external inputs (as in-situ input production is important characteristics of natural farming). This increase in weightage for agronomical courses as elective courses is indication of increase in attention for education on soil, plant and water management. This signifies the role of agronomy in graduate level education. Besides that, agronomic courses are also offered in different disciplines at graduation level such as crop production and protection technology and farming based livelihood system in B. Tech. (Agricultural Engineering), farming based livelihood system in B.Sc. (Hons.) forestry, introduction to major crops and principles and practices of natural farming in B. Sc. (Hons.) horticulture and introduction to agronomy and crop production technology, sustainable farming system and precision agriculture and farming based livelihood system in B. Sc. (Hons.) agribusiness management. This indicates the interdisciplinary impact of agronomical courses at graduation level.

Agronomic education at post-graduation level and at higher education level

The master level education is differing from graduate level in many aspects such as duration/ credit hours, major and minor subjects and credit hours allocated to research and thesis/ dissertation. In terms of agronomical courses separate courses for individual groups of crops such as cereals, pulses and oilseed, and commercial crops will provide more insight in to cultivation practices of arable crops. Besides that, improved course such as modern concepts in agronomy and experimental techniques in agronomy, soil, plant water analytical courses will provide the useful analytic knowledge for conducting the research activities. The credit seminar and comprehensive examination are another important part of both M. Sc. and Ph. D. degree programme. Besides that, widening range of minor subjects are another important interventions in agronomy at post-graduation level. The most common minor disciplines in

agronomy are soil science and agricultural chemistry, plant physiology, agricultural statistics, environmental sciences and microbiology; while this range can be further widened with other disciplines such as agri. engineering, post-harvest technology, agrochemicals, agricultural economics, plant breeding, horticulture and plant biotechnology. The proportion of course work and research is reverse in M. Sc. and Ph. D. programme with higher research and lower course credit in Ph. D. level is also important. Considering the higher diversity of activities involved in both M.Sc. and PhD degree programme and being more specialization, there are great changes for intervention which are discussed in next section of this article.

Interventions, potentials and considerations at graduate level

The interventions at graduation level have been consistently attended through DCR and this can be clear from the changes in courses, credit allocation and status of courses (compulsory courses, core courses and elective courses). Besides that, changes in content of courses (for example addition of conservation agriculture in organic farming course, changes in course “Geo-informatics, nano-technology and precision farming, etc.) and other specification (such as field and laboratory requirements, experiential learning programme and rural agricultural work experience) will also indicate the role of DCR in intervening the graduate programme in agriculture. Based on review of changes made across DCR in earlier sections and DRC, some the interventions are given herewith: 1) Increase in credits for agronomy up to 25 for compulsory, core and elective courses; 2) Considering soil, plant and water management related courses and aspects in agronomy subjects along with individual aspects of input and stress management in different crop production systems; 3) Inclusion of separate course on tillage and conservation agriculture; 4) Inclusion of new course for commercial crops and medicinal and aromatic plants; 5) Increase recognition of vegetables crops in agronomical courses (for examples potato, onion, chilli, tomato, etc.); 6) Inclusion of more and applied portion of pest and diseases management of agronomical crops as a part of up gradation of “weed management” course to “stress management in agronomical crops”; 7) Inclusion of separate course on “nutrient management” or up gradation of “water management” course to “nutrient and water management”; 8) Reduction in credit allocation to non-essential courses (as done by combining practical crop production course with crop production technology in VIth DCR); 9) Addition of bioinput production courses as separate course with only practical credit hours or include one credit hour for bioinput production in natural farming or organic farming course; 10) Attention to resource allocation for creating basic field infrastructure (with recurring cost for purchase of tools, implements and consumable items for field activities); 11) Informative academic material generation should be promoted through facilitating and creating scope for academic publication; 12) More exposure to new innovative IoT things to students through moderation of courses for such aspects.

Interventions, potential and considerations at post- graduate and higher education level

The publication of one review article based on either credit seminar or background information collected for selected topic of research. This will give the scientific outcome to the efforts made by students while preparing credit seminar or collecting and reviewing of literature for thesis writing. This will also have positive impact on thesis writing skill and insure quality of

thesis. In case of Ph.D., two such critical review articles is possible as there are mostly two credit seminars for Ph.D. students and research activities (credit hours allocated) is also more as compared to MSc (around 2 times). The improving scientific writing skill, scientific outcomes in terms of publication and increased attention towards research can be achieved in this way. Improvement in data representation and making it more suitable for publication and communication of valid scientific information is most important. In this regards some important intervention will be as given herewith: 1) Expressing growth parameters in secondary data form such as crop growth rate, relative growth rate, net assimilation ratio and dry matter partitioning at different growth stages rather than representing primary data such as total above ground dry matter accumulation alone; 2) Exclusion/ substitution of those growth attributes with other observations such as changing plant height with root growth parameters which do not contributes much to yield attributes; 3) Inclusion of soil biological properties as these properties are significantly affected by most of the crop cultivation practices and input addition. These properties may be dehydrogenase activity, microbial biomass carbon, microbial biomass nitrogen, alkaline phosphatase activity, acid phosphatase activity, soil total polysaccharides, acetylene reductase activity, etc; 4) Inclusion of auxiliary / rate parameters at physiological level such as light interception pattern, photosynthetic rate, transpiration rate, etc. will help in studying the exact impact of field scale management on such attributes; 5) Observations on crop microclimate such as canopy temperature, crop canopy relative humidity, light penetration in crop canopy, etc. will also add to scientific gain to applied treatment variable. The information on such crop microclimate and auxiliary/ rate parameters are lacking for field scale treatment variables and hence it will gain acceptance in scientific communication; 6) The energy calculation in crop production at field scale will be another way to increase the scientific information generation for different treatment variables (and not only for tillage and crop establishment methods). In fact complete budgeting is possible (as subsidized prices and variation in pricing systems is not there in case of energy) in converting all input and outputs in single energy unit. At the same time, share of energy sector to footprint on agro-ecosystem is higher and consideration of energetics in different types of activities will provide scope for such type of energy calculations; 7) There should be inclusion of minimum 2 to 3 factors of crop production in research proposal rather than concentrating on single factor. This will increase the information generation on interaction effects of factors which at present a valuable scientific and applied information; 8) Besides that studying effect on impact on soil, plant, water and stress will bring completeness rather than concentrating on growth, yield and quality parameters alone. The study or observation on residual effect will also helpful in handling field to next experiment there by maintaining continuity in experiment and its effect accounting; 9) Beside data generation and taking observations, its analysis and presentation will also play an important role in generating valid, new and variety of conclusions. Therefore, some of new statistical tools/ software/ packages at M. Sc. and Ph. D. level will be worthy and needed to increase the scientific outcomes; 10) In order to keep pace with new production practices, proactive involvement M. Sc. and Ph. D. research on testing and evaluation of different bioinputs used in natural farming (NF) and organic farming (OF) is essential to harvest the scope generated in this new and highlighted production practices. The concentration, rate, time and method of application that too with crop specific

recommendation is need to be developed and calibrated; 11) The Agronomic biofortification/ ferti-fortification/ micronutrient fertilization has been tested and investigated for impact on plant and soil; while interaction of such treatment variables with water, weed and pest management and their different methodologies across production system such as conservation agriculture, OF and NF is still need to be explored. This will gives broad idea about suitability of agronomic biofortification across crops and production systems; 12) The research on functional nutrient and micronutrients (excluding zinc and iron) and their interaction with other factors of production will be another area of investigation having crop and production system specific scientific prospects in future; 13) The Ph. D. research proposal may be made more scientifically important by diverting attention to new range of crops such as underutilized crops and location specific crops (Millets, cumin seed, coriander, fenugreek, etc.), vegetable crops (onion, potato, cowpea, clusterbean, pea, different types of bean, etc.) and medicinal and aromatic plants (mentha, lemon grass, citronella grass, etc.) in cropping system mode (intercropping/ relay cropping/ mixed cropping/ multistory cropping, etc.) with diversified production system (CA, OF and NF) in comparative way; 14) Investigation and testing of new fertilizer formulation (for examples nano-fertilizers, fortified fertilizers and nano-fertilizer) as well as multi-nutrient fertilizers (rather than restricting on mixed and complex fertilizers) in crops and production systems will also important future thrust area of research to be considered; 15) The nutrient interactions studies with combination of organic and inorganic sources of nutrition as well as in CA, OF and NF need to be considered as future line of work in study of nutrient

interactions; 16) The preparation of Dean Committee Report for M. Sc. and Ph. D. programmes on the same line as that for graduate DCR will also a futuristic intervention which will help in bringing holistic uniformity in higher education in agriculture; 17) The decrease credits hours at Ph. D. level on major subject and increasing on minor subject and on research will also a future potential area of investigation; 18) Allocation of Ph. D. research in farmers field condition or involvement of farming community/ farmers/ key person in advisory committee as well as allocation of Ph. D. student based on sub-subject wise rather than admission to single entitlement as “Agronomy”; 19) Increase in collaboration with basic sciences and increase in recognition to conservation agriculture, natural farming and organic farming; 20) Increase in attention to post-harvest aspects as one objective as there is increase in ready to eat, ready to cook and ready to serve products even in arable crops as well; 21) Compilation and contribution of agronomical data to large data bases, modelling approach as well as several other uses; 22) Incorporating the concept of monetization of Ph. D. research which can be achieved with several avenues such as testing of new fertilizers materials, bioinputs (bio-pesticide, bio-stimulants, etc.) and agrochemicals prepared by different private and/or public firms and development of sellable products/ technology. Beside that most important thing in describing the intervention is that, the principle of flexibility in these activities is need to be insured rather than compulsion approach through elective/ selective credit hours mode or additional certification mode or allocation marks/ grades to these activities or creating separate research themes.

Table 1: Courses offered for Agronomy discipline in last three Dean Committee Reports.

A. Courses offered for Agronomy discipline as per Fourth Dean Committee Report (2007 to 2017).		
S. No.	Course Name	Credit Hours [Total (Lecture + Practical)]
1.	Principle of Agronomy and Agricultural Meteorology	3 (2+1)
2.	Field crops-I (<i>Kharif</i>)	3 (2+1)
3.	Weed Management	2 (1+1)
4.	Water Management including Micro-irrigation	3 (2+1)
5.	Field crops-II (<i>Rabi</i>)	3 (2+1)
6.	Farming Systems and Sustainable Agriculture	2 (1+1)
7.	Practical Crop Production – I (<i>Kharif</i> crops)	1 (0+1)
8.	Practical Crop Production – II (<i>Rabi</i> Crops)	1 (0+1)
9.	Introductory Agriculture (Ancient Heritage, Agriculture Scenario and Gender Equity in Agriculture)	1 (1+0)
10.	Organic Farming	3 (2+1)
	Total	22 (13+9)
B. Courses offered for Agronomy discipline as per Fifth Dean Committee Report (2017 to 2024).		
S. No.	Course Name	Credit Hours [Total (Lecture + Practical)]
1.	Fundamentals of Agronomy	4 (3+1)
2.	Agricultural Heritage [^]	1 (1+0)
3.	Introductory Agro-meteorology & Climate Change	2 (1+1)
4.	Crop Production Technology – I (<i>Kharif</i> crops)	2 (1+1)
5.	Crop Production Technology – II (<i>Rabi</i> crops)	2 (1+1)
6.	Farming System and Sustainable Agriculture	1 (1+0)
7.	Practical Crop Production - I (<i>Kharif</i> crops)	2 (0+2)
8.	Practical Crop Production - II (<i>Rabi</i> crops)	2 (0+2)
9.	Principles of Organic Farming	2 (1+1)
10.	Geo-informatics and Nanotechnology and Precision Farming	2 (1+1)
11.	Rainfed Agriculture & Watershed Management	2 (1+1)
12.	Rural Agricultural Work Experience – Agronomy	3 (0+3)
13.	Weed Management [#]	3 (2+1)
	Total	28 (13+15)
C. Courses offered for Agronomy discipline as per Sixth Dean Committee Report (2024 onwards).		
S. No.	Course Name	Credit Hours [Total (Lecture + Practical)]
	Common course	

1.	Farming based livelihood systems	3 (2+1)
	Core courses	
2.	Fundamentals of Agronomy	3 (2+1)
3.	Crop Production Technology-I (<i>Kharif</i> Crops)	3 (1+2)
4.	Crop Production Technology-II (<i>Rabi</i> Crops)	3 (1+2)
5.	Water Management	2 (1+1)
6.	Weed Management	2 (1+1)
7.	Introductory Agroforestry	2 (1+1)
8.	Dry land agriculture/ Rainfed agriculture and watershed management	2 (1+1)
9.	Principles and Practices of Natural Farming	2 (1+1)
	Elective courses	
10.	Principles and Practices of Organic Farming/ Conservation Agriculture*	4 (3+1)
11.	Geo-informatics and Remote Sensing, precision farming*	4 (3+1)
12.	Management of natural resources *	4 (3+1)
13.	Climate resilient agriculture *	4 (3+1)
		22+16* (11+11) + (12+4)*

Note: (^: The course does not exactly belong to agronomy; while it is being given course title as that of other agronomy sources; #: Elective course to be offered in 4th or 5th or 6th semester; *: Elective courses).

(Anonymous 2007; Anonymous 2017; Anonymous, 2024) ^[1, 2, 3]

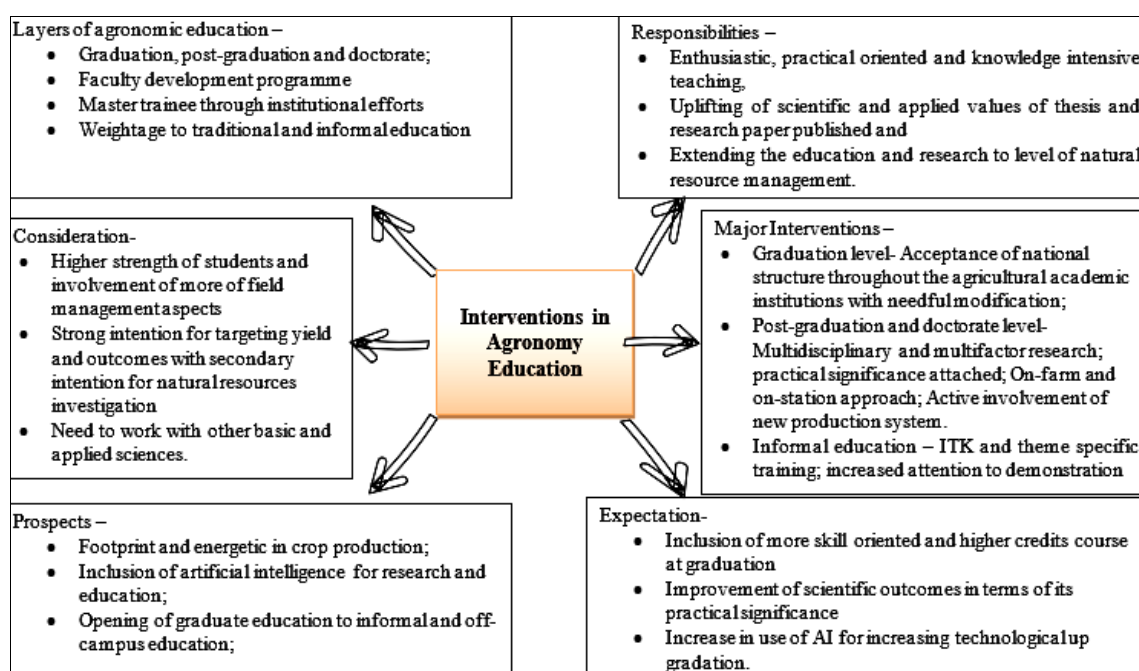


Fig 1: Perspective of agronomy in agricultural education system

Conclusion

The intervention in agronomy courses and research at graduate and post- graduate level are dynamic and need to address the time and space/ location (Agro-climatic) demands. The three themes with the principles and practice of these themes need to be highlighted in agronomic education viz., crops/ plant production and protection activities, principles soil, plant and water management and more inclusion of natural resource sciences. The future prospects from this article is that the regulations and amendments in agronomy courses and research need a well-organized body of agronomist to suggest time to time interventions to national governing bodies such as Dean Committee Report.

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