

Illustrative Quotations for Values of Bangladeshi Female Farmers and Strategies to Address Them in Agriculture Apps

TABLE I: Results of RQ1: Bangladeshi female farmers' present and missing values in agriculture apps (INW: Interviews; FG: Focus groups; ✓: Present values; ✗: Missing values; ☞: Quotes from interviews; ☞: Quotes from focus groups)

Values	INW	FG	Illustrative Quotes (INW & FG)
Accuracy	✓1 (I2)		☞ "The female farmers gave feedback that the information in the apps is 90% accurate. For example, weather prediction. They said if the apps predict rain, usually it rains, otherwise at least the day remains cloudy."- I2
Capability		✓3 (G1, G2, G4)	☞ "The apps made us capable of solving agriculture related problems. Even, with the help of the apps, we are now able to answer all the questions regarding crop cultivation."- G2
Honesty	✓1 (I12)		☞ "In their village, there is a tendency of pesticides adulteration and sell those by slightly changing the names of some popular brands. For example, Atibrite instead of Antibrite. The app stops this dishonest activity by providing original pesticides' pictures so that the female farmers can match the names while buying."- I12
Independence	✓4 (I6, I10, I11, I13)	✓2 (G1, G2)	☞ "Previously we were dependent on our husbands for everything. Now, with the help of the apps, we can produce crops by ourselves, do not need to ask for money and can bear the costs of our kids' education."- G1
Creativity	✓3 (I8, I9, I10)		☞ "We tried to design apps in a creative way. We provided a feature of automatically crops' picture taking, like scanning, and sending to us. Another interesting feature used female farmers' own voices to record app contents and added as audio files."- I9
Learning	✓6 (I1, I3, I6, I7, I8, I9)	✓3 (G1, G2, G3)	☞ "We learned about 4 ft length and 2 ft width bedding from the apps which increased our production. From apps, we also learned how to take care of livestock, when to give medicine, how to build their house etc."- G1
Responsibility		✓1 (G1)	☞ "With the help of the apps, now we know everything about agriculture better than our husbands. Therefore, nowadays, our husbands completely rely on us and we take all the responsibilities of cultivation."- G1
Security	✓3 (I7, I8, I9)		☞ "The app we developed for them was offline app, so nobody can hack. For another app, we ensured that all of them create an ID and password for the security purposes."- I9
Tidiness	✓3 (I2, I7, I8)		☞ "They became very happy with the tidy way of giving information on dose of medicines and precautions to apply those medicines on crops. We provided this information with different colors and they really liked it."- I8
Self-respect		✓3 (G1, G2, G4)	☞ "With the help of the apps, now we are able to assist our husbands in agriculture activities and money making. It increased our respect. Even our in-laws do not make any decision without our opinions."- G4
Simplicity	✓3 (I9, I10, I11)	✓3 (G1, G2, G4)	☞ "During the app development, we kept in mind that the app will be used by the farmers. So, the app we developed has the advantage of being easy and simple."- I11
Social recognition		✓3 (G1, G2, G4)	☞ "I gained much knowledge from apps. About me, people usually say, "She has much knowledge on agriculture". Sometimes they come to me to know information. I feel very proud then as I am much knowledgeable than other hundreds women."- G1
True-friendship	✓3 (I8, I10, I11)		☞ "The female farmers in a village have a good friendship among themselves. We provided some recorded information by using some of their voices. The others became very excited to listen to their friends' voices in the apps."- I8
Unity with nature	✓3 (I2, I7, I9)	✓2 (G1, G2)	☞ "From the apps, we know different disaster-resistant varieties of crops. For example, a variety of paddy called the BR1156 is flood-resistant. Now heavy rain, flood even cyclone cannot destroy our crops."- G1
Wealth		✓3 (G1, G2, G3)	☞ "My husband tried fish farming for two years but he lost 60000 BDT. Then I got information from the apps on prawn farming and asked my husband to let me try this. In one year I got 120000 BDT as profit."- G3
Accessibility	✗3 (I1, I3, I12)		☞ "We should work on the apps to increase the accessibility for the female farmers."- I1
Pleasure	✗2 (I1, I8)		☞ "They like illustration than text. But most of the apps are full of text; no picture, no animation, no audio-video. So, they might not find the apps interesting."- I8
Privacy	✗3 (I8, I10, I11)		☞ "Privacy is a big concern for Bangladesh's perspective. I don't think it's being properly emphasised yet in the apps. Users are not getting their data protection."- I11
Safety		✗1 (G2)	☞ "In the apps, there is no information on diseases which usually attack crops in flood-prone areas. As we live in flood-prone area, we need to be aware of these diseases and their remedies so that we can take precautions before flood."- G2
Tradition	✗5 (I1, I2, I8, I9, I10)		☞ "Developers usually follow the structures of the apps built for other developed countries. It won't work for marginalized women in Bangladesh. Their tradition is completely different and you should take care of it."- I1
Trust	✗3 (I4, I8, I11)		☞ "Trust is a big issue for the female farmers. Why should they trust an app? At the very first place, three things should be focused while developing apps- Trust, Security and Privacy. Developers are not aware of these during apps development."- I4
User-friendliness	✗5 (I1, I2, I5, I7, I8)	✗2 (G1, G3)	☞ "None of the apps are user-friendly for Bangladeshi female farmers, they do not even care about female farmers' education level. They are full of bookish knowledge with many scientific terms. Even, developers never reach out to the farmers to get their feedback on how much user-friendly an app is."- I2

TABLE II: Results of RQ2: Strategies to address Bangladeshi female farmers' values in agriculture apps (if the strategy emerged from the- 🗣️: interviews; 👥: focus groups; 🗣️👥: both; 🗣️: Quotes from interviews; 👥: Quotes from focus groups)

Groups	Strategies	Illustrative Quotes
Functionalities	🗣️ Strategy 1: Adding New Features to Extract and/or Meet Farmers' Values	🗣️ "It is important to add a feature on providing feedback so that the users can immediately inform what problems they are facing and what are their expectations. It would inspire more female farmers to use the app and also help developers understand the users' values."- I5
	🗣️👥 Strategy 2: Adding Concise and Customized Information/Contents	🗣️ "Besides the regular weather phenomena, sometimes Bangladesh faces extreme natural disaster such as, flood, cyclone, drought. Hence, it is necessary to provide information on weather prediction and agriculture advise to keep the productions safe during any unwanted natural disaster."- I2
	🗣️👥 Strategy 3: Updating Agriculture Information Regularly	👥 "Crop diseases change with time and weather which we do not know how to deal with. Therefore, updated information needs to be added regularly in the apps."- G1
Awareness	🗣️ Strategy 4: Enhancing Developers' Non-technical Knowledge	🗣️ "Developers' should build social knowledge as well because they always start thinking from technical perspectives where thinking from social perspectives is also important to address female farmers' values in apps."- I4
	🗣️ Strategy 5: Changing Developers' and Farmers' Mindset	🗣️ "We can't force female farmers to use apps; it's about shifting their mindset. They need to see that spending 20 BDT on internet to use the apps can save them thousands in production. This mindset change will happen gradually, not overnight."- I1
Work process practices	🗣️ Strategy 6: Applying Human-Centered Approaches to Elicit Values	🗣️ "Developers often see user-centered design as the holy grail to address values in apps, but I recommend design thinking as an updated approach. It can be applied to understand the values of the users, to realize the challenges involved and to design the prototypes of apps accordingly."- I13
	🗣️ Strategy 7: Prioritizing Female Farmers' Values	🗣️ "If you find many values of the female farmers, there must be some values which are the most important to them. Therefore, value prioritization is necessary before developing apps."- I13
	🗣️ Strategy 8: Reducing The Communication Gap Between Farmers and Developers	🗣️ "There is a significant gap between the community and technical people. Since developers don't visit female farmers directly, their requirements pass through multiple layers, often leading to modifications of the original needs."- I5
	🗣️👥 Strategy 9: Customizing Apps Based on User Literacy Levels	👥 "Other than text, images of different crop diseases and their symptoms would be helpful for us as many of us are not fluent in reading. In fact, video will be the best."- G3
	🗣️ Strategy 10: Considering Bangladeshi Culture When Developing Apps	🗣️ "If you want to make an app for the female farmers in Bangladesh, you cannot follow the structure of an app developed for other countries even for other societies. You need to respect their culture while developing apps for them, with unique UI/UX, interactions, language, and content."- I1
	🗣️ Strategy 11: Engaging Users in All Steps of Apps Development	🗣️ "We should include users from the beginning of app development. In fact, we should include them in all steps of software development life cycle to develop values-based apps."- I4
	🗣️👥 Strategy 12: Taking Feedback in Person Regularly	🗣️ "We always think that we developed an app and our task is over. This is not the right way. We need to visit and talk to the users in every 2-3 months to know their feedback and should update the app accordingly."- I9
Team structure and responsibilities	🗣️ Strategy 13: Establishing a Dedicated Team/Person for Values Concerns	🗣️ "Analyzing feedback through a values' lens is crucial to understanding farmers' values. A new role can be introduced for this purpose only. It can be a dedicated team or person to analyze feedback with both their technical and social knowledge."- I4
	🗣️👥 Strategy 14: Adjusting Existing Roles and Responsibilities	🗣️ "I don't think any new role need to be introduced to design apps that respect human values. I believe the existing roles like product owner and UX designer should be able to take more responsibilities to address values in apps."- I13