

1 **How do fruit and vegetable markets operate in rural India? A qualitative**
2 **study of the impact of supply and demand on nutrition security**

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20 **Shortened title**

21 Fruit and vegetable value chains in India
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25 **Ethical Standards Disclosure**

26 This study was conducted according to the guidelines laid down in the Declaration of
27 Helsinki and all procedures involving human subjects were approved by the University of
28 Southampton ethics committee. Written informed consent was obtained from all subjects.
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30

31 **Abstract**

32

33 **Background:** Diets in rural India are cereal-based with low intakes of micronutrient-rich
34 foods. The value chains for nutrition approach aims to study supply and demand of such
35 foods. This may aid in development of interventions to improve diets and livelihoods.

36 **Objectives:** 1) to identify how fruit and vegetables are accessed; 2) to describe and map the
37 structure of value chains for exemplar foods; 3) to understand how foods are priced; and 4) to
38 explore factors that affect decisions about which crops are grown, marketed and sold.

39 **Methods:** We identified 2 fruit (mango and guava) and 2 vegetable (shepu and spinach) value
40 chains after stakeholder consultation. Criteria for the foods were that they should be known to
41 study participants and there should be variability in intake of these foods.

42 We held 24 interviews with value chain actors including farmers, wholesalers and vendors of
43 the exemplar foods. Data collection was stopped when no new information emerged. We
44 used inductive thematic coding for our analysis.

45 **Results:** The value chains for each of the exemplar foods were relatively simple and involved
46 farmers, middlemen and vendors at either city or village level. The main themes identified as
47 being factors considered when making decisions about which foods to grow and sell were: 1)
48 Farming resources and assets; 2) Quality of produce; 3) Environmental conditions; 4)
49 Financial factors; 5) Transport availability; 6) Consumer demand.

50 **Conclusions:** There are opportunities to intervene within fruit and vegetable value chains to
51 increase availability, affordability and access to produce in rural India. **Future research is**
52 **required to determine which interventions will be feasible, effective and acceptable to the**
53 **community and other stakeholders.**

54

55 **Keywords:** agri-nutrition, fruit, India, value chain, vegetable, qualitative research

56

57 **Introduction**

58 India has experienced rapid economic growth in recent years but undernutrition remains a
59 public health problem. Despite being classified as a lower middle income country the burden
60 of undernutrition in India is greater than in some low-income countries according to the
61 Global Hunger Index 2016.¹

62

63 Diets in rural India are often comprised largely of staple carbohydrates including rice and
64 wheat.^{2, 3} They are frequently lacking in micronutrient-rich foods.^{2, 4-8} We focused on fruit
65 and vegetables because they are nutritious foods that are acceptable to the majority in a
66 country where vegetarianism is prevalent. The WHO recommends 400g of fruit and
67 vegetables/ day for the prevention and alleviation of several micronutrient deficiencies.⁹ This
68 target is not achieved for most of the rural Indian population due to lack of availability and
69 affordability.¹⁰ Our study area comprised villages around Wardha in rural Maharashtra, India.
70 Dietary data from this area indicates that wheat, rice and sorghum (millet) are the staple
71 cereal foods.¹¹ Intakes of virtually all micronutrient-rich foods have been reported to be
72 below 20% of the Recommended Daily Intake (RDI), for example mean daily consumption
73 of green leafy vegetables is less than 10g/day and fruit is 16g/day compared with a RDI of
74 100g/day for both food groups. Half of the women were chronically energy deficient
75 (BMI<18.5kg/m²) and over 75% of non-pregnant non-lactating women were anaemic.¹¹

76

77 It is increasingly recognised that a detailed understanding of food value chains may be an
78 important means to improving nutrition and health outcomes in such settings.^{12, 13} For the
79 purposes of this research the term ‘sector’ is used to define a series of activities that add value
80 to a product. Actors within the value chain carry out these activities and in relation to this

81 research, actors include farmers, wholesalers and vendors. For example, farmers take the
82 inputs required to grow vegetables and add value by producing crops; wholesalers transport
83 the crops to market and may be involved in some processing or packaging activities; vendors
84 market and sell crops to consumers.

85

86 The agriculture sector comprises cultivation of food and non-food crops as well as rearing of
87 animals. Recent growth in the agricultural sector has been reported to be a more effective
88 means of poverty alleviation than growth in other sectors as it tends to be an occupation
89 engaged in by some of the poorest among the labour force.¹⁴ To date, agricultural growth in
90 India has largely been associated with increased cereal production.¹⁵ Despite this, 30% of
91 women living in rural areas of the state of Maharashtra had a BMI below 18.5kg/m²
92 according to representative survey data.¹⁶ In addition to chronic energy deficiency, diet
93 quality is often poor. For example, a recent analysis of food balance sheet data found that a
94 quarter of the Indian population are at risk of inadequate vitamin A intakes. This figure was
95 over 50% for folate, riboflavin and calcium.¹⁷ Promotion of fruit and vegetable cultivation
96 and an understanding of barriers to fruit and vegetable production could lead to increased
97 food and nutrition security and hence improved health outcomes.¹⁸

98

99 **It** is important to understand how markets for fruit and vegetables operate in order to ensure
100 that they are sustainably available and accessible. Value chain approaches to nutrition have
101 been proposed as a means of determining how supply and demand factors impact on food and
102 nutrition security.¹² These approaches aim to identify the people (actors) and processes
103 (activities) within a supply chain and thereby to understand how decisions are made in terms
104 of production, marketing and selling of foods. This may provide opportunities to intervene

105 and create 'win-win' scenarios whereby diet quality can be sustainably improved and poverty
106 among those who work within the agriculture sector can be reduced.

107

108 A recent review of value chain interventions in India found that approximately half involved
109 naturally nutrient dense foods such as meat, fish, dairy, millets, pulses, fruit and vegetables.¹⁹
110 These include interventions to improve linkages between farmers and vendors so that value
111 chains are shorter and prices are more stable.²⁰ Just over a quarter of interventions involved
112 foods of increased nutritional value such as fortified foods and the remaining quarter
113 involved the distribution of foods such as in the mid-day meal programme for school
114 children.¹⁹

115

116 It has been reported that Indian farmers realise only about 30-35% of the value of their
117 produce compared with 65-70% in developed countries.²¹ Modifying value chains and the
118 way they are financed can be part of a comprehensive livelihood model enabling small
119 farmers to benefit from sustainable and profitable farming.²¹ For example, a recently
120 implemented project called MilkIT aimed to develop dairy-based livelihoods through value
121 chain development in India. The project has achieved improvements in women
122 empowerment; sharing of knowledge and technologies between farmers has improved animal
123 feed. Furthermore, self-help groups have enabled development of new enterprises and
124 increased incomes for farmers.²²

125

126 We conducted a value chain analysis in Wardha district, a rural part of the State of
127 Maharashtra in India. Our objectives were to: 1) identify how fruit and vegetables are
128 accessed 2) describe and map the structure of value chains for exemplar products; 3) to
129 understand how products are priced; and 4) to explore factors that affect decisions about

130 which crops are grown, marketed and sold and to understand the perceived barriers to
131 producing and supplying fruit and vegetables in this region.

132 **Methods**

133 This study was qualitative in design and comprised 24 one to one interviews aimed at
134 mapping value chains for exemplar fruit and vegetables and understanding decisions made by
135 value chain actors with regards to the foods that they produce, market and sell. We used a
136 participatory approach in designing the research and involved members of the community in
137 the development of the methods in order to learn from their knowledge of the local situation.

138 **This process is further described below in the section entitled ‘Choice of Exemplar Foods’.**

139 Ethical permission was granted by the University of Southampton Ethics Committee and all
140 participants gave informed consent in writing.

141 **Study setting**

142 The data collection took place from September 2015 to February 2016 in Wardha and
143 surrounding districts (Wardha and Deoli blocks) and villages in Eastern Maharashtra. This
144 region is highly dependent on agriculture for food and income. It is a challenging
145 environment with temperatures regularly exceeding 45°C (113 Fahrenheit) in the summer
146 months (April, May and June). There is frequently inadequate and unpredictable rainfall
147 during the monsoon season (June – September). The agricultural land is mainly rain-fed and
148 used for commercial crops including cotton and soya bean²³. The majority of the workforce
149 are occupied within the agriculture industry. In rural areas of Wardha district, literacy rates
150 are 82% and 85% for women and men respectively ¹⁶ 95% of households have electricity but
151 only 53% have adequate sanitation facilities and only 42% use clean fuel for cooking.¹⁶

152

153

154 **Choice of Exemplar foods**

155 We held a stakeholder workshop in Wardha in May 2015, one of the aims of which was to
156 determine which exemplar fruit and vegetable value chains would be mapped and studied in
157 detail. The workshop was attended by 18 stakeholders of a total of 25 that had been invited.
158 Stakeholders were invited based on their role within government and non-governmental
159 organisations with an agriculture, livelihoods or health remit. The attendees included
160 members of the Maharashtra State Rural Livelihood Mission; Zilla Parishad (elected
161 members of the District Council); representatives of farmers' unions; consumers; farmers and
162 vendors. The session was led by the authors VD and SK.

163 The criteria for selecting these exemplars were that they were known by the vast majority of
164 consumers and that there was some variability in intakes of these foods within the study
165 population. This would then enable us to study both barriers and facilitators to consumption
166 of the foods. The foods that were chosen based on these criteria were mango, guava, shepu
167 (dill leaves) and spinach.

168

169 **Mapping of Exemplar Value Chains and Identification of Value Chain Actors**

170 We held 12 interviews with women of reproductive age (18-40 years) living in eight villages
171 surrounding Wardha during which we asked about consumption of the exemplar foods and
172 about how they accessed these foods.²⁴ Based on their responses we identified and made
173 contact with the vendors of these foods. We interviewed a purposive sample of these vendors
174 based on where they sold their products (with one vendor serving each of the eight villages).
175 We identified one wholesaler per vendor, the vendor made the introduction and we invited
176 them for interview (n=8). Similarly each wholesaler identified a producer (n=8) who we also
177 subsequently interviewed.

178

179 **Interviews**

180 A total of 24 in-depth interviews were held with 8 vendors, 8 wholesalers and 8 farmers in
181 locations convenient to the interviewees, usually in the markets or at the interviewee's home.
182 No financial or other incentives were offered but tea and snacks were provided to the
183 interviewee prior to the discussion. All interviews were held in the local language of Marathi.
184 They were digitally audio tape-recorded, transcribed and translated to English.

185

186 The interviewers (VD, SB and RK) were part of the research team and were all trained in
187 qualitative methods prior to conducting the research. They had not met the respondents prior
188 to the interview; all interviewers were native to the state of Maharashtra. The interviews were
189 conducted in the respondent's place of work which was either the market, farm or street.
190 Nobody other than the interviewer and the interviewee were present. The interviews were
191 guided by a schedule (available on request) which was informed by discussions at two
192 stakeholder workshops held in Mumbai and Wardha in May 2015. Briefly, the value chain
193 actors were asked in detail about whether and how they made decisions about which foods to
194 grow, market and sell. They were also asked about difficulties they faced in the value chain
195 activities that they were involved in. We stopped conducting interviews when no new themes
196 emerged from the data.²⁵ We conducted sufficient interviews to reach the point of saturation
197 and to ensure that we had the same number of participants from each of the groups of value
198 chain actors.

199

200 All of the interviews were analysed together. For objective 4, we used thematic analysis to
201 identify emerging themes from the interviews and an inductive coding approach was used to
202 code the data. Three transcripts were used to create an initial coding frame and this was
203 applied to all further transcripts. The coding frame was continually discussed and adapted

204 based on new information from the transcripts. Four researchers (VD, SB, RK and SK) read
205 and coded the transcripts and, following discussion, the final coding template was created.
206 The final template was applied to all transcripts by SK.

207

208 **Results**

209 This section presents our findings in relation to our four objectives 1) how consumers in the
210 study villages accessed fruit and vegetables in general; 2) a description of the exemplar fruit
211 and vegetable value chains; 3) how products were priced; 4) the emerging themes from
212 interviews with value chain actors in terms of how they made decisions about value chain
213 activities. We identified six emerging themes as described in section 4 below.

214

215 **1) Access to Fruit and Vegetables**

216 Consumers living in the study villages reported accessing fruit and vegetables from their own
217 kitchen gardens; as gifts from neighbours and family members; door-to-door vendors within
218 the village; village or district level markets which tended to be held weekly; and the city
219 market in Wardha.

220 Consumers and other value chain actors reported a shift from the previous practice of
221 shopping and marketing locally towards fruit and vegetables being bought and sold in the city
222 of Wardha. It was stated that this was due to the price being lower in the city compared with
223 the villages and that villagers were prepared to travel to Wardha to buy produce.

224

225 **“Nobody buys from villagers now. People get it [fruit] from Wardha. They cannot**
226 **afford to buy from villagers.”** (Farmer and village-level vendor)

227

228 **“In villages, little fruit is sold. Actually the price of fruit in the city and in villages are**
229 **very different. In the city the price is less than in villages. Villagers mostly visit Wardha**
230 **so they come and buy all the stuff from here.”** (Fruit shop vendor in Wardha)

231

232 Furthermore, transport within the city is easier for vendors rather than traveling to villages to
233 sell produce. Wealthy consumers in Wardha were better able to afford fruit and vegetables
234 and so the demand was higher in the city than in the villages.

235

236 **“At Wardha there are continuous modes of commuting. In places where transport is**
237 **available it is affordable to buy produce to sell”** (City vendor)

238

239 **“People living in the city can afford fruit but rural people don’t have money for these**
240 **things”** (Wholesaler).

241

242 We found there were two main types of vendor, ‘producer vendors’ who grew their own
243 crops and ‘market vendors’ who purchased produce from either farmers or wholesalers and
244 sold it on. Vegetables were usually harvested and sold on the same day. Mangos were either
245 harvested ripe and sold within a day or two, or harvested early and artificially ripened.

246

247 **2) Exemplar Value Chains**

248 Based on the consumer and value chain actor responses, we produced diagrams to depict the
249 supply chains of the exemplar foods (figures 1-3). All of the chains described to us were
250 relatively simple with some value chain actors engaged in more than one activity e.g.
251 producer vendors. The produce that was not sold by farmers was bought by contractors
252 before the fruit was harvested in the case of mangos and after harvest by wholesalers in the

253 case of guava, spinach and shepu. In the case of mango, the fruit was often picked before it
254 was ripe and then artificially ripened. Wholesalers then sold the produce on to vendors at city
255 and district level markets from where it was purchased by village level vendors and
256 consumers.

257 **“I sell it to the wholesaler. He ripens the stock with carbide and the next day he auctions**
258 **it.”** (Mango Farmer)

259

260 **3) Pricing of Products**

261 According to the farmers and wholesalers we spoke to, decisions about product pricing were
262 largely made by wholesalers. Farmers did not command a specific price for their produce and
263 stated that they had to accept the price offered to them by the wholesaler or vendor. Price was
264 usually determined by supply and demand. In times of low production, the price would be
265 high and vice versa when there was overproduction prices were low. Quality was also a
266 determinant of price.

267 Wholesalers and vendors described selling produce that they had bought from farmers at a
268 profit. They also described the process by which the produce is passed along the value chain.
269 There are increments in price at each stage and these cover the commission earned by the
270 wholesaler and any their transport costs.

271

272 **“The wholesaler decides the price. We just have to take the produce to Wardha”** (Fruit
273 farmer)

274

275 **“Irrespective of our wish we can’t decide the price of our produce. If production is low**
276 **then rates are high and if production is high then rates are lower. If the quality of the**
277 **produce is good then we get 5-10 Rupees (0.08-0.15US\$) more per kg.”** (Fruit Farmer)

278

279 **“I sell guava to a wholesaler. First he investigates the fruit production and on that basis**
280 **he decides the rate and then buys the fruit. No one asks the farmer.”** (Guava farmer)

281

282 **“Wholesalers get commission from both sides. Suppose I am a farmer producing goods.**
283 **I put my goods on his selling platform, he then sells the goods to another businessman.**
284 **The other person then sells the stuff to a third person at double the rate. There is a price**
285 **increment at each stage. So we buy something worth 10 Rupees (0.15US\$) for 15 Rupees**
286 **(0.23US\$) and then sell the same thing for 30 Rupees (0.45US\$). We have to get**
287 **commission otherwise there is no point in selling anything. If we do not earn a penny or**
288 **two in a business then the business is meaningless. It is like that.”** (Fruit vendor)

289

290 **“Farmers come to us with their produce which we sell. We bargain a little bit. We**
291 **deduct our commission fees, porter charges and pay them. The retailers buy the stock**
292 **from us and they sell it on the handcart. A few of them have shops in the city.”**

293 (Wholesaler)

294

295 Vendors who were able to store produce purchased from wholesale markets stood to make up
296 to 30% profit if they sold them on at smaller, district markets. For example, a mango vendor
297 in a district level market reported buying produce from a wholesale market, keeping it at
298 home overnight and then transporting it to Deoli market the following day.

299

300 **“If we purchase at 60 to 70 rupees (1 US\$) per kg, we sell on at a rate of 100 rupees**
301 **(1.50 US\$) per kg.”** (Mango vendor)

302

303 **4) How value chain actors make decisions – emerging themes**

304

305 Based on objective 4, we identified six emerging themes as having an impact on which
306 varieties of fruit and vegetable were produced, marketed and sold by the value chain actors.

307 These were i) Farming resources and assets; ii) Quality of produce; iii) Environmental
308 conditions; iv) Financial factors; v) Transport availability; vi) Consumer demand. These
309 themes are now presented in detail:

310

311

312 **i) *Farming resources and assets***

313 Farmers talked about several difficulties with resources. Finding reliable labour was
314 described as being a challenge due to the seasonality of farm work. For example, during the
315 cotton harvest the majority of farm labourers will work on cotton farms and will not be
316 available to work on fruit or vegetable crops. Farmers also had to prioritise their activities
317 based on the season and profitability. This meant that they would harvest cotton rather than
318 sew vegetables because cotton was a more profitable crop.

319

320 **“Labour problems are encountered during the cotton season. Nobody wants to work on
321 our farm then.”** (Vegetable Farmer)

322

323 **“Due to lack of time, we cannot cultivate vegetables because we have other farm work.
324 Like now the farm is ready for sowing vegetable seeds but this is the time of cotton
325 harvesting so we need to concentrate on cotton because it is an important crop.”**

326 (Vegetable Farmer)

327

328 Access to water in the form of irrigation was talked about as a major facilitator or barrier to
329 production. Some farmers stated that they had access to irrigation and this meant that they did
330 not have to depend on the rain. Irrigation was not always reliable as it was dependent upon
331 the electricity supply. When this was impaired, no water was available for crops.

332 **“My farming is not dependent upon rain. This area is very good. Here the water dam is**
333 **available, irrigation is available.”** (Fruit farmer)

334

335 **“We have irrigation but often there is a problem with the electricity that powers this.**
336 **Then our crops can’t be watered.”** (Farmer)

337

338 Access to inputs such as seed, pesticides and fertilisers were discussed and decisions about
339 which crops to grow were based on what seeds were affordable and available to farmers.

340

341 **“Seeds are very costly. Sometimes it is difficult to even recover the money invested in**
342 **the seeds.”** (Vegetable farmer)

343

344 Lack of storage facilities at the production and market points of the value chain were
345 discussed. Farmers were limited on what they could grow due to lack of storage. They
346 therefore were forced to grow produce that they could sell on straight after harvest. Vendors
347 also talked about how the lack of storage means they must sell as much stock as possible
348 before it deteriorates in the heat. If produce is not sold promptly the quality is affected and
349 this leads to a lower selling price being achieved. For some vendors this meant that they did
350 not make any profit and therefore could not pay themselves a wage.

351

352 **“We cultivate only those vegetables that we harvest and sell immediately.”** (Farmer)

353

354 **“We don’t get any facilities at all. If we don’t sell it [fruit] early in the day our business**
355 **will be lost because the fruit has a short shelf-life.”** (Fruit vendor)

356

357 **“Our stock lasts for two days, by the third day it is not as good so we have to sell it at a**
358 **lower price. Then we do not earn any money.”** (District-level vendor)

359

360

361 *ii) Quality of produce*

362 Value chain actors talked about the importance of maintaining the freshness of fruit and
363 vegetables. This meant that there was a tight schedule from harvesting crops to selling them
364 in the market. Farmers said they would receive a higher price for their produce if the quality
365 was maintained. Furthermore, vendors had to consider the quantities that they dealt with in
366 order to ensure that they did not suffer losses due to spoilage or wastage. Customer loyalty
367 was mentioned by interviewees as being important. If vendors sold poor quality produce, this
368 was likely to affect their business and customers might purchase fruit and vegetables
369 elsewhere.

370

371 **“[Our produce] is fresh so the wholesaler gives a different price for that produce. They**
372 **know when the produce is harvested. If the produce is harvested a day prior and it is**
373 **taken to the market the next day then one can see that the produce is stale. We harvest**
374 **in the morning at 6.00am and then it has to reach the market by 7.00am. If you harvest**
375 **in the evening and take it to the market the next morning then it is of no use. You would**
376 **not get a good price as the produce would be stale.”** (Vegetable Farmer)

377

378 **“They [vegetables] get spoilt if we get them in excess. We have to be careful when**
379 **getting the goods.”** (Vegetable door-to-door vendor)

380

381 **“If I sell fresh vegetables, then I can’t lose regular customers.”** (Vegetable vendor)

382 *iii) Environmental conditions*

383 Farmers and vendors talked about how environmental factors, such as strong winds or heavy
384 rain, affected which products they could grow and sell. Financial risk associated with
385 growing certain crops and the unpredictable weather in the area was described. Farmers
386 talked about the financial loss they suffered as a result of adverse environmental conditions.

387

388 **“Last rainy season 700 trees fell down due to the wind. I lost nearly one and a half lakh**
389 **[150,000 Indian rupees =2260US\$].”** (Mango Farmer)

390

391 There was also discussion about the threat wild animals posed to the crops including wild
392 boar, elephants, deer, birds and monkeys. This threat was considered severe enough for
393 farmers to spend the night in the fields watching out for these animals in order to prevent
394 them causing damage. Pests and crop diseases were a problem for many of the farmers.

395

396 **“Before there were no animals. No wild pigs. Now the animals are a menace. They are**
397 **destroying the red gram (lentil) and fresh bengal gram (chickpea) crops.”** (Vegetable
398 Farmer)

399

400 **“Wild animals attack the green produce. There are wild pigs and deer. For that reason**
401 **we have to stay in the field. I was away for 15 days and the animals attacked my cow**
402 **peas in the field and ate everything. I did not sell a single pod of cow pea. The entire**

403 **field was wiped out. The painstaking efforts of two months were ruined in one day. That**
404 **is why we have to stay in the field. I'm thinking of preparing a hut sort of thing to stay**
405 **there.”** (Vegetable Farmer)

406

407 **“These trees produce a good crop every year. I do not have any other problems except**
408 **that of parakeets; 80% of the crop is eaten by the parakeets.”** (Mango farmer)

409

410 There is a tension between preserving wildlife and livelihoods in the region which was
411 described by farmers. Killing certain wildlife is against the law and so farmers have to come
412 up with interventions to prevent the animals from entering farms.

413

414 **“The Government doesn't allow us to kill wild animal hence we use an electric fence to**
415 **keep them away from the farm.”** (Fruit farmer)

416

417 Season was mentioned as having an important effect on the availability of crops and also on
418 demand for fruit and vegetables. During the monsoon or rainy season, produce tends to perish
419 rapidly due to the hot and humid conditions and there are an abundance of pests that destroy
420 crops. During the summer, when temperatures can exceed 50°C, produce dehydrates very
421 rapidly and the quality is lost.

422

423 **“In the rainy season vegetables get spoiled easily. In winter, vegetables are fresh and in**
424 **summer, they get dry within one day. The best season is winter.”** (Vegetable Farmer and
425 Door-to-Door Vendor)

426

427 **“In summer, it is hot and windy so vegetables get dried out easily. We have to take care**
428 **of vegetables like a small baby”.** (Door-to-door vendor)

429

430 *Interviewer: “How does the demand vary by season?”*

431 *Interviewee: “In the rainy season vegetables are attacked by pests. How can anyone buy*
432 **rotten vegetables? In summer the availability of vegetable is very poor therefore they**
433 **sell easily.”** (Farmer and Door-to-door Vendor)

434

435 At times when farm-workers were busy, such as during the monsoon, and therefore had no time
436 to visit the market, the vendors reported that business was poor. During winter, when fruit
437 production was reduced, fruit was perceived as being a luxury, or something to eat if suffering
438 from an illness.

439

440 **“Business is dim in the monsoon because people work for daily wages. How can they come**
441 **to the market?”** (Fruit vendor)

442

443 **“Vegetables are essential, groceries are essential. Fruit is not an essential thing you see!**
444 **It is bought by those who are not well.”** (Fruit vendor)

445 **“Season affects production. We have to take care a lot in the summer; we have to wrap**
446 **the vegetables in a wet cloth.”** (Farmer/ Door-to-door Vendor)

447

448

449 *iv) Financial factors*

450 The profitability of growing, marketing and selling crops was discussed by the interviewees.

451 This was an important and universal aspect of the decision making process in terms of which

452 products to work with. Seasonal fluctuations in price were mentioned in relation to green
453 leafy vegetables. When discussing the cost of fruit, it was apparent that buying produce from
454 door-to-door vendors was more expensive than traveling to markets. In the summer the costs
455 of buying fruit from village vendors was often considered prohibitive. Demand around
456 festivals made certain crops more lucrative to grow and sell.

457

458 **“In the rainy season production of vegetables is high hence prices are low but in**
459 **summer production of vegetables are low hence prices are high.”**

460

461 **“There is a good price for coriander during Nag Panchami (festival during monsoon),**
462 **so I cultivate coriander 1-1.5 months before this festival.”** (Vegetable farmer)

463

464 **“During Navratri (festival at the end of monsoon/ early winter), we purchase stock at a**
465 **higher price so we also sell it at a higher price.”** (Deoli fruit and vegetable vendor).

466

467

468 The timescale for producing crops was talked about. Farmers chose to grow vegetables rather
469 than fruit because of the relatively short time required between sowing and harvest. They
470 were not able to invest in fruit crops and wait for a return.

471

472 **“Coriander is ready within 4-6 weeks and shepu within 4-5 weeks. I am not interested in**
473 **fruit cultivation. If I grew guava it would take 3 years to get the fruit. Until then, how**
474 **can I manage for money?”** (Vegetable farmer).

475

476 **“Seeds are costly. Previously, when I used to cultivate fenugreek, seed was available for**
477 **30-40 rupees (0.45 – 0.60 US\$) per kg. Now it costs 100 rupees (1.50 US\$) per kg. If**
478 **everyone takes vegetables to the market the price of vegetables falls. It is difficult to**
479 **recover the money invested in the seeds. We should take the produce to the market**
480 **when there is no stock in the market.”** (Farmer/ Wholesaler).

481

482 *Interviewer:* **“When you buy from farmers, who decides the price?”**

483 *Interviewee:* **“We decide. We have to keep watch on the supply of the stock to decide the**
484 **price. When we go to the market in the morning we get an idea of the supply and the**
485 **price.”** (Vegetable Wholesaler)

486

487 A farmer / vendor told us that they sold green leafy vegetables in bundles and that the size of
488 these varied according to the price that could be achieved.

489

490 **“If the rate is high then I tie a small amount in one bundle and if the rate is low then I tie**
491 **a larger amount in one bundle.”** (Farmer/ Door-to-door Vendor)

492

493 **“Spinach is expensive in the summer so we get a good price for it. We have to make the**
494 **effort and then we get profit.”** (Farmer/ Door-to-door Vendor)

495

496 Vegetable cultivation was considered to be a source of regular income for the day-to-day cost
497 of living compared with cash crops such as cotton. Return from cash crops was generally
498 received in lump sums and spent on larger projects.

499

500 **“I feel vegetable cultivation is a profitable business because we get recurring cash**
501 **income. Cotton is a seasonal crop and with this income, we can do major work such as**
502 **improvements to the farm. With the vegetables we get a daily income of 100 Rupees**
503 **(1.50 US\$) per day, with this we take care of our daily expenses.”** (Farmer / Wholesaler).

504

505 Wholesalers gave examples of wastage when local production of a crop was high and demand
506 was low. They also talked about how their losses were mitigated with profit from other
507 products.

508

509 **“In the month of December there was a large amount of tomato production. Also, the**
510 **demand for tomatoes was very low, the customer was not willing to purchase them. We**
511 **had to throw the crop away”.**

512 **“With the profit we get from other stock we manage our losses from tomatoes.”**
513 (Wholesaler).

514

515

516 **v) *Availability of transport***

517 The quantities of produce that could be transported to markets were dependent on the method
518 of transportation. A simple upgrade from a basket to a hand cart made a huge difference to a
519 vendor’s business. Many local level vendors have to transport all of their produce by foot
520 which limits the area that they can cover and therefore their income. In addition, where motor
521 transport was required, it was often difficult for the farmers and vendors to come by. They
522 would often have to spend hours waiting for transport in the heat. By comparison, value chain
523 actors with their own motor vehicles were well in a more advantageous position.

524

525 **“The business has flourished [after getting hand cart]. I used to carry 5 kg in a basket.**
526 **In this I can manage 10 kg.”** (Vegetable vendor)

527

528 **“The problem is that it is inconvenient work. For selling [vegetables], we have to walk a**
529 **lot which is inconvenient.”** (Farmer/ Door-to-door and District level vendor)

530

531 **“sometimes we cannot find any auto-rickshaws to get the produce to the village. We**
532 **have to wait for as long as two hours. We get oppressed due to thirst and hunger. If we**
533 **had our own vehicle then we could get the stuff to the village straight away. But we have**
534 **to depend on others.”** (Farmer and village level vendor).

535

536 **“We take our produce to Wardha by auto rickshaw. It is affordable because we have**
537 **our own vehicle. Otherwise one trip costs 200 Rupees (3 US \$).”** (Vegetable Farmer and
538 Wholesaler)

539

540 For vendors who procured goods from city or district level markets to be sold on at village
541 markets or door-to-door, transportation of fruit and vegetables was a daily task with a cost to
542 be factored in.

543

544 **“We get vegetables every morning. Vegetables will only be sold when they are fresh, they**
545 **do not last. We require 200 Rupees (3.00 US\$) and they charge a fare of 100 Rupees**
546 **(1.50US\$) for the bags of vegetables.”** (Village level vendor)

547

548

549

550

551 *vi) Consumer Demand*

552 Migration to the city as a result of companies providing employment was described as having
553 an impact on the market for fruit and vegetables in Wardha. Wholesalers stated that the
554 population was increasing as a result of the migration and this meant that sales of vegetables
555 in Wardha were increasing. A divide between urban and rural people in terms of ability to
556 afford fruit and vegetables was described, and particularly for fruit, although the demand for
557 mangos was perceived as being universal. Mango was considered essential even by the
558 poorest customers. These customers would always buy as much of these products as they
559 could afford. Poorer customers, typically those in rural areas, could not afford certain fruit
560 such as guava.

561

562 **“The population of Wardha is growing day by day, it is because of industrialization in**
563 **Wardha. Companies like Lanko etc. are in Wardha. Due to this we are selling more**
564 **vegetables.”** (Vegetable Wholesaler)

565

566 **“Guava is not getting a good rate in the market because there is no demand in the**
567 **market. People don’t have money to buy it. People living in the city have it but rural**
568 **people don’t have it. Farmers don’t have money. Everyone wishes to have orange,**
569 **papaya with every day meals but farmers don’t have money.”** (Fruit Farmer)

570

571 **“In this village the demand for mangos is greater than other fruits. There are many**
572 **villages near this market so people purchase 5 to 8 kg of mangos per family. In the**
573 **village the family size is bigger than in the city. Smaller family size means a lower**
574 **quantity of fruit is sold.”** (District level vendor)

575

576 “Even the poorest man would buy mango as per his paying capacity. But if you ask that
577 man how many times he had sweet lime in the last year, he would answer once or twice
578 in a year.” (Fruit vendor).

579

580

581 **Discussion**

582 We used qualitative methods to study fruit and vegetable value chains and to examine factors
583 that influenced actors within these chains in rural Maharashtra. We found that the supply
584 chains were relatively local and comprised a small number of actors and processes, compared
585 with more elaborate value chains often observed in urban and international settings.²⁶ Many
586 of the actors in the chains had multiple roles within the chain and were themselves
587 consumers.

588 In the villages where we conducted the research, there appeared to be a shift occurring from
589 **consumers** purchasing produce at the village level to purchasing at the city **level**. This was
590 causing difficulties for consumers in terms of availability, and for producers in terms of
591 transport. It means that the poorest consumers and those living in more remote areas cannot
592 access affordable fruit and vegetables particularly during times when supply is compromised.

593 **Further work to identify the most effective interventions is necessary, but approaches to**
594 **resolve these issues could include: 1) increasing local production of fruit and vegetables**
595 **through community or kitchen garden interventions; and 2) addressing the negative attitudes**
596 **and beliefs associated with consumption of indigenous fruit and vegetables that grow**
597 **abundantly in and around the villages.**

598

599 The risks associated with producing a particular crop were largely taken on by the farmers,
600 and **included risks of** financial losses as a result of wild animal or weather damage.

601 Furthermore, farmers had little, and often, no say over the price that their produce was sold
602 for. It is understandable in this context that farmers and land owners decide to grow cash
603 crops such as cotton in order to protect themselves against the risk of growing food crops.
604 The prioritisation of cotton farming deprives fruit and vegetable farmers of labour at
605 important times of the year. These are major challenges and will require multi-sectoral
606 actions. Possible solutions, that would require consultation with farmers and other
607 stakeholders as well as government or industry support would be to: 1) offer farmers
608 affordable insurance policies against loss of fruit and vegetable crops; and 2) offer financial
609 subsidies to farmers to grow fruit and vegetables.²⁷

610

611 The decline in demand for indigenous vegetables that don't require large amounts of water or
612 agri-chemicals was talked about by consumers.²⁴ These findings are comparable with a study
613 among tribal households in Jharkhand, India in which it was found that overall intakes of
614 indigenous foods were low, yet those women who did consume them had higher intakes of
615 calcium and iron than those who did not.²⁸ Addressing this decline in demand through
616 promoting the cultivation of these plants and educating consumers may lead to a 'win-win'
617 scenario in that local production of, and demand for, nutritious foods is increased.^{29, 30}

618

619 Addressing infrastructure challenges, such as improving power supply to irrigation systems,
620 will require sustained government support and investment. Other approaches to reduce
621 transport time and costs could include providing better physical infrastructure for local
622 periodic markets and improved storage facilities. Issues of wild animals consuming or ruining
623 crops highlight an extremely sensitive and difficult conflict between humans and other
624 species. This will require strategic planning and careful land and forest management.

625

626 Price volatility affected all value chain actors and led to large amounts of wastage. It also
627 meant that several products, particularly fruit, were too expensive for many consumers. A
628 large multi-country study investigating availability and affordability of fruit and vegetables¹⁰
629 found that in low and middle income countries over 20% of rural inhabitants were unable to
630 afford three servings of vegetables and two of fruit per day. It was also found that
631 consumption of these foods decreased as relative cost per serving increased. The authors
632 noted that there is a lack of systematic monitoring of food prices³¹ and that the costs of fruit
633 and vegetables are not part of national estimates of cost of major food commodities published
634 by UN agencies including the World Bank³² and Food and Agriculture Organisation.³³

635

636 **Study Limitations**

637 There are some important limitations to note in this study. We recruited value chain actors
638 based on their availability and willingness to take part in an interview. It is possible that the
639 factors affecting fruit and vegetable consumption among chain actors who were not able and/
640 or unwilling to participate were different from the themes we identified.

641

642 **Conclusion**

643 In conclusion, this qualitative work indicated that there may be several opportunities to
644 intervene within fruit and vegetable value chains to increase availability, affordability and
645 access to good quality produce. **These opportunities may include, but are not limited to: 1)**
646 **kitchen or community garden interventions; 2) behaviour change in terms of consumption of**
647 **indigenous fruit and vegetables; 3) offering farmers insurance, subsidies or both; and 4)**
648 **infrastructure and land management. Further quantitative research is required to determine**
649 **which interventions will be feasible, effective and acceptable to the communities.**

650 While undernutrition continues to be prevalent in rural parts of India it is important to
651 consider how public health messages are developed and targeted given the increase in
652 overweight and obesity in India.³⁴ It is important also to consider how the adverse health
653 effects associated with the ‘nutrition transition’ described in low and middle income countries
654 can best be prevented in rural areas which have thus far had little exposure to this transition.
655 ³⁵⁻³⁷ Evidence suggests that fruit and vegetables are protective against non-communicable
656 diseases³⁸ whereas increased consumption of processed foods associated with the nutrition
657 transition is likely to be harmful.³⁷ As such a market-based approach to increasing their
658 consumption in which all value chain actors and processes are considered is likely to be
659 required to achieve this end.

660

661 **Future Research**

662 This was a qualitative study in which we wanted to get the perspectives of people who work
663 within the value chain. In order to prioritise interventions, it may be advisable to conduct a
664 survey among a larger group of value chain actors based on the findings of the current study.
665 The aim of the survey would be to obtain quantitative data on the challenges faced by actors
666 as well as prices of fruit and vegetables, costs incurred by actors in the value chains and their
667 profit margins. These data could then be used to conduct cost-benefit analyses of
668 implementing candidate interventions to improve supply of and demand for fruit and
669 vegetables in this setting. Further work to understand the synergies and trade-offs associated
670 with growing fruit and vegetables may be advisable in order to determine how nutritional
671 yield can be optimised. Such a study could comprise a similar analysis to that conducted by
672 DeFries et al whereby cereal crops were assessed for nutrient yield per hectare and other crop
673 attributes such as resilience to variability in precipitation and temperature.³⁹ In the case of
674 fruit and vegetables this would involve measuring the nutrient content of crops grown in

675 different soil, temperature and moisture conditions to determine how to maximise the nutrient
676 content for the local environment.

677

678 We suggest some ideas for possible solutions to these issues: 1) to offer farmers affordable
679 insurance policies against loss of crops; and 2) to offer financial subsidies to farmers to grow
680 fruit and vegetables.

681 Addressing this decline in demand through promoting the cultivation of these plants and
682 educating consumers may lead to a ‘win-win’ scenario in that local production of, and
683 demand for, nutritious foods is increased.^{29, 30}

684

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692

693 **Authorship**

694 SHK, KK, AG, R, and CHDF formulated the research question and designed the study. SHK,
695 KK, VD, SB, RK, SAS, RDP carried out the study. SHK, VD, SB, RK, analysed the data and
696 interpreted the findings. SHK wrote the manuscript and all authors contributed to the drafting
697 of the manuscript, reviewed its content and have approved the final version submitted for
698 publication.

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857 Figure Legends

858

859 Figure 1: Example of a mango value chain

860

861 Figure 2: Example of a guava value chain

862

863 Figure 3: Example of a spinach or shepu value chain

864

865 Figure 4: Examples of supply and demand constraints for fruit and vegetables and potential

866 interventions